MINISTRY OF WATER AND IRRIGATION

Water Resource Policy Support

WATER REUSE COMPONENT

ECONOMICS STUDY FOR MANAGING WATER REUSE IN THE AMMAN-ZARQA BASIN & THE JORDAN VALLEY

By

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Acknowledgments

I am indebted to MWI staff for a stimulating meeting in which we talked about how best to meet Jordan future fresh water requirements and how to use effectively the growing supplies of recycled water. We talked about how to apply economic , social, budgetary, and other Governmental concerns when considering engineering-based alternatives. Those attending the meeting from the Ministry=s side were Eng. Nazeer Abuarqoob, Director Environment Directorate; Eng. Suzan Taha, Director MIS Directorate; and Eng. Edward Qunqar, Director Water Resources Directorate; as well as Eng. Rania Abdel, Eng. Mohammed Mansour, and Eng. Yasser Nazzal. And, as before, I wish to thank the ARD staff resident in Amman for their cheerful and competent support. My special thanks go out to Dr. Peter McCornick to whom I reported, to Dr. Thomas Cusack, chief-of-party, to Yasmin, Administrative Assistant, to Ramzi and Nisreen for their technical support, and to the Sabri, who picked me up at the airport at 3:30 a.m., and to Mustafa, who would have done so had he not had another assignment. Without exaggeration, this was the most smoothly run operation that I have encountered in an oversees setting during more years of work than I care to recall. My experiences in this wonderful country have been a delight. I can only hope that Jordan will one day find the fresh water it needs for its growth and prosperity.

List of Abbreviations

ARD	Associates in Rural Development
AZB	Amman-Zarqa Basin
HL	Highlands
HRZ	Hashemite-Rusefieh-Zarqa area
JV	Jordan Valley
JVA	Jordan Valley Authority
JICA	Japanese International Cooperation Agency
KTR	King Talal Reservoir
MCM	Million cubic meters
MWI	Ministry of Water and Irrigation
NIR	Net irrigation requirements
NPW	Net present worth
SO	Stage Office
USAID	United States Agency for International Development

Executive Summary

This summary contains the highlights of my second consulting assignment for the Water Reuse activity of the Water Resource Policy Support project. Whereas my first assignment dwelt with an economic evaluation of Highland irrigation that would receive recycled water pumped through a pressure line, [1] this assignment had a much broader scope that required an economic appraisal of options that would free up freshwater, as well as provide recycled water to the Jordan Valley.

The approach was to review the 15 options for water reuse contained in the Draft Interim Report (MWI/ARD, April 2001) for the purpose of choosing those to study carefully, those deserving comment, and those that this consultancy would skip over. As background we discussed forecasts of municipal water demand and discharges from As Samra, water quality for municipal use, the opportunities within the industrial sector for using recycled water, and agricultural profitability in the Jordan Valley.

The criteria we selected for evaluating the cost of freshwater was in terms of *fils per cubic meter delivered to the Amman-Zarqa Basin and treated, when necessary, to meet municipal standards*. As for the beneficial use of recycled water in the Jordan Valley, we relied on *annualized benefits and costs* using a 40-year life and a social discount rate of 10 percent. Costs for most of the options involved constructing a pipeline along with the associated O&M and pumping costs, and, in some cases, desalination. We estimated agricultural benefits according to net revenues per dunum multiplied times the land area affected.

Our review of the Groundwater Action Plan of the Draft Interim Report yielded two useful values when costing freshwater resources. On the low side, at essentially zero cost to the economy,[2] are farmers wanting to be bought out because of their unsatisfactory financial position. At the other extreme is the fossil water of the Disi project, valued by the World Bank (1997) at 709 fils/m^3.

[1] My first assignment involved evaluating three Highland options for possible use of recycled water (HL#2a, HL#3, HL#4). The focus was primarily on evaluating, from an economic perspective, the feasibility of developing new lands by pumping water through a pipeline. Because the nearest location showed poor economic results, the report (Shaner, November 2000) found it unnecessary to carry out analyses of the other two alternatives. The approach paid only passing attention to the amount of freshwater that might be saved at HL#3 and HL#4.

[2] Zero cost from the national perspective because farmers anxious to be bought out could be just breaking even financially, not counting the intrinsic value of the water they are exploiting. Removing their farming activities leaves the economy no worse off economically. Of course, the Government would need to pay these farmers to get them to cease pumping from their wells; but this is what economists call a *transfer payment*--something that does not add to or subtract from the total economic output of the country.

As will be seen in the body of this report, we reviewed four possibilities for substituting recycled water for freshwater. We did not attempt to estimate the unit costs of freshwater for the Highlands Irrigation Distribution Network (HL#4) because of the belief by MWI and ARD staff that implementation of this option is impracticable. Following is a summary of the four options.

Northern Directorate Option (JV#3): This option combines one component that would divert 57 MCM of freshwater annually from the King Abdullah Canal (KAC) and pump it via the pipeline currently under construction to the Zai treatment plant in Amman, and to another component that would deliver 57 MCM of recycled water annually via a gravity pipeline from Wadi Zarqa to Northern Directorate farmers whose freshwater would be taken from them. Since the Directorate receives an average of 69,000 MCM of freshwater annually, some of the farmers will still have access to 12,000 MCM of freshwater annually. Since we assume that the application rate is approximately 1,000 CM per dunum, the areas affected by this option are 57,000 dunums receiving recycled water and 12,000 dunums receiving freshwater. We anticipate that farmers receiving recycled water would switch their cropping patterns away from citrus, which does not do well being irrigated with recycled water, to vegetables. Net revenues from the vegetable crop would probably be similar to that obtained by farmers in the Middle Directorate. We also assume that those farmers still receiving freshwater would have their yields reduced slightly because the smaller amount of water would probably mean less certainty of supply. Total annualized costs, including pipeline and on-farm investment, operating costs, pumping freshwater to the Zai plant, and farmers= losses comes to JD24.3 million per year, which for 57,000 MCM per year produces a unit cost of 426 fils/CM of freshwater delivered to the Zai plant.

Wadi Dhuleil (HL#3): This option involves building a 14 km pressure pipeline to deliver annually 2.5 MCM of recycled water to replace an equal amount of freshwater currently being pumped as part of Dhuleil Irrigation project. All of the 2,100 dunums currently being irrigated[3] would experience an increase in yields, especially for vegetables because the groundwater has become considerably more saline than the recycled water to be delivered to the area. Total annualized costs, including pipeline investment and its operation and net of farmers gain in productivity come to JD1.2 million. For a savings of 2.5 MCM of freshwater annually, this comes to 467 fils/CM. In addition, the freshwater must be treated to reduce the salinity at an estimated cost of 500 fils/CM; but no freshwater delivery costs are incurred because the point of use is either near by or downhill. Together, the annualized and treatment costs total 967 fils/CM of freshwater available for municipal use in the Amman-Zarqa Basin (AZB)--considerably above the Disi option.

Greater Wadi Dhuleil (HL#3a): This option envisages an expansion of HL#3 to include additional farmers surrounding the Dhuleil irrigation project, who draw from deep wells using their privately-owned pumps. The quality of this water is considerably better than that of HL#3; so, treatment costs are less. Total annualized costs at JD4.5 million are considerably greater for this option because of its larger size, but when the amount of freshwater saved (i.e., 9.5 MCM) is counted, the unit

[3] Uses 1,200 CM per dunum on the assumption that most of the land is planted in fruit trees, which requires more water than do vegetables.

cost of freshwater before treatment is 476 fils/CM--similar to that for HL#3. The biggest difference between these two Dhuleil options is the cost of treatment, which for HL#3a, would be only 130 fils/CM. Combining the two costs brings the total to 606 fils/CM of freshwater available for municipal use in the AZB.

Hashemite-Rusefieh-Zarqa, HRZ, Area (HL#1): This option involves construction of a 17 km pressure pipeline to the Hashemite-Rusefieh-Zarqa industrial area, primarily to serve the industrial cooling requirements of the refinery and two power plants, one of which remains to be built. Total recycled water requirements would be 13.0 MCM to replace an equal amount of water now pumped, or would be pumped, from the Amman-Zarqa aquifer. Because the salinity levels are high and industrial specifications for cooling water are also high, the affected industries would (and currently do) bring the salinity levels down to standards similar to those required of freshwater for municipal use. Pumping and treatment costs of the well water would be the same whether it is used by industry for cooling or by the municipality for household consumption. But the recycled water must be treated, probably as part of the As Samra expansion and upgrade. Without benefit of specific information, we have assumed a treatment cost of the recycled water that is lower than that industry currently incurs because of the more favorable salinity content of the recycled water. Total annualized costs of the pipeline and its operation are JD1.8 million, which divided by 13.0 MCM saved each year gives a unit cost of 136 fils/CM. Adding to this an estimated treatment cost of 250 fils/CM brings the total to 386 fils/CM of freshwater available for municipal use in the AZB, which is the lowest of the four options.

The foregoing calculations revealed how recycled water can contribute to increased supplies of freshwater available for municipal use. The calculations also revealed the wide spread of costs, ranging from a low of 386 fils/CM for the Industrial option to a high of 967 fils/CM for the Wadi Dhuleil. If the Government assigns its highest priority to the use of recycled water for replacing freshwater, as well it might, then the next in line, in terms of contributions to the national economy would be the use of recycled water for industrial purposes. Generally speaking, industry requires relatively small quantities of water per unit of output (vegetable canning would be an exception); the absence of an adequate supply comes at a high opportunity cost in terms of foregone income for the economy. This means that those who plan the allocation of recycled water should be certain that industry (existing and planned) is well provided for. While the Government has a social obligation to see that those currently farming are not denied the water they are accustomed to receiving, at least in quantity if not in quality; it should be aware of the inferior productivity of water in agriculture.

As a prelude to looking at the profitability of agriculture in the Jordan Valley, we derived net returns per dunum for the Northern, Middle, and Karameh directorates based on values for each Stage Office. Our results were in terms of the national perspective (actually those based on market prices) and the farmers= perspective: the latter by removing most of the labor costs so as to arrive at net returns to family labor and management. The build-up of values began with cropped area, as provided by ARD, and yields, unit prices, and production costs, as found in the Forward reports (June 2000). Our findings confirmed the *general wisdom* that the Northern Directorate is the most productive area and the Karameh Directorate is the least. Below are the results.

NET RETURNS

	Northern	Middle	Karameh
	----------------JD/dunum-------------------		
National perspective	217	154	106
Farmers= perspective	269	263	179

The reason that the farmers= perspective for the Middle Directorate gains on that from the Northern Directorate is that the Northern Directorate is planted largely in citrus, which uses modest amounts of labor, and that of the Middle Directorate is mostly planted in vegetables, which uses considerable amounts of labor. With this information we could calculate the economic effects of the three options the Jordan Valley. Following is a summary of each.

Northern Directorate (JV#3): Recall from the earlier description of this option that it contained two components: one for the delivery of freshwater to Amman and the other for the delivery of recycled water via a gravity line to the farmers. Conceptually, at least, these two components can be analyzed separately, and in this case the analysis assumes that the Northern Directorate has already lost 57 MCM/year of its freshwater supplies and would, therefore, be largely operating under rainfed agricultural conditions. This analysis looks at the net revenues produced by bringing recycled water to the area which would be receiving only 12 MCM/year of freshwater for irrigaiton. The costs of delivery are those shown earlier, while the estimate of benefits combine the net revenues from using recycled water on 57,000 dunums and freshwater on the other 12,000 dunums. In measuring net revenues we assumed that cropping patterns, yields, unit prices, and production costs for the 57,000 dunums would be similar to those in the Middle Directorate and that net revenues for the 12,000 dunums would be reduced by ten percent from historical values because of the smaller supply. The results show a relatively small annual loss of JD 609,000 over the whole 69,000 dunums By increasing our estimate of the net revenues per dunum by only seven percent (from JD154 per dunum to JD165 per dunum) this component of the option breaks even. Such a small increase is well within the margin of error of our estimates. So, rather than abandon the farmers of this directorate over such a small loss, prudence would suggest that recycled water be delivered to the area.

Middle Directorate (JV#2): The Government=s action concerning this option is simply to allow additional diversions of 6.0 MCM of recycled water per year to farmers in this directorate. No other action is required, since facilities are already in place for use of this additional quantity of water. The anticipated result is an intensification of cropping along the lines now being practiced by farmers there. Our estimate of the amount of additional water that could be used is based on bringing the area cropped when water is scarcest to the average of the areas planted during the two other seasons when water deliveries to the area are not restricting. Using historical net returns from this quantity of water produces net annual revenues of JD2.2 million, assuming farmers can produce three vegetable crops per year.

Karameh Directorate (JV#1): By being at the tail end of the KAC system this southern-most directorate receives the least amount of water with the least degree of certainty, which helps explain the low net revenues per dunum. To add to KAC deliveries, farmers in Stage Office 6 and Stage Office 9 resort to pumping from the saline aquifer below their land and from water flowing in the drainage ditches. Stage Office 10 has its own freshwater sources, but could use additional supplies of water.

This option combines construction of a 5.5 km pressure pipeline to the Stage Office 10 area with the allocation of roughly 40 MCM of recycled water yearly for the whole directorate. With this additional water, farmers should be able to expand production on 34,000 dunums and intensify production on another 5,600 dunums. We have assumed net revenue increases, whether new or intensified, to match the Middle Directorate in terms of profitability; however, new production requires on-farm investment similar to that estimated for Highland farmers by Shaner (2000). The results are net annual increases in revenues of JD3.1 million. Returns to a representative share cropper indicates that such a person would earn enough income to slightly exceed the average rural income in Jordan, while giving the land owner a 15 percent return on his investment. Both results are considered to be modestly acceptable.

Other Options: This report comments, without calculation, on two other issues concerning discharges from the As Samra plant. One of these is the use of recycled water by farmers bordering Wadi Zarqa. The Government would like to restrict, rather than promote, the use of such water, because of its concern over domestic health and the reactions of foreign buyers of Jordan's fruit and vegetables. But, farmers adjacent to the Wadi will probably continue to divert the water as they see fit. Thus, our suggestion is simply to allow for such use when allocating recycled water supplies. The other issue concerns saving surplus flows of the KAC by recharging the local aquifer. The concept has economic merit; but the practicality awaits further study.

The final part of this report comments on how these options might be combined into alternative future scenarios for implementation. We looked at the relationship between growth in both municipal water demand and discharges from As Samra. Critical to the relationship between these two factors are the assumptions of population growth overall and for the Greater Amman-Zarqa area, the assumed increase in per capita water consumption, and the difference in volumes between municipal water consumed and recycled water discharged. Of the options, Northern (JV#3) would save the most freshwater, i.e., 57 MCM per year. But, according to our analysis, as just described, these extractions from KAC must wait until an equal quantity of recycled water becomes available for farmers in the Northern Directorate, which according to the projections would not occur until 2015. By this date, if the projections hold true, all of the 57 MCM could be applied directly to meet municipal demand and Highland pumping for municipal purposes could be reduced by an equal amount, which should benefit this Highland aquifer. The Industrial option (HL#1) yields the next largest supply of recycled water, and does so at the least cost. Finally, deliveries to both the Middle and Karameh directorates show good economic returns.

The report's findings reveal two important points: *first, the four options, along with Disi water, can meet the projected municipal water demand well beyond the planning date of 2025; and the combined demand for recycled water by the five options*[4] *exceeds for an even longer period.*

Introduction

The Ministry of Water and Irrigation (MWI) and its general consultant, Associates in Rural Development (ARD), have developed a series of options for providing additional fresh water for municipal use in the Greater Amman-Zarqa Basin and for making beneficial use of the recycled water discharged by the As Samra Treatment Plant. Together, the two groups have begun formulating scenarios that comprise an effective grouping of the more relevant options. The purpose of my consultancy was to evaluate these various options and to consider an approach to scenario formulation. So as to focus this report's efforts on the more relevant issues and to present its findings over a wide range of options, much of the technical detail about options have been omitted. The interested reader can find such detail in the many reports now available in ARD's Amman office. While my task has of necessity concentrated on economic factors, I am aware that purely economic matters seldom sway governmental decision makers entirely. They rightfully must consider social, political, administrative, and budgetary matters as well. While it would be nice to look at some of the macroeconomic issues such as the way the options contribute to the country's employment and foreign exchange needs, the detailed economic calculations required by the many diverse options forced such considerations out of the picture.

My previous consultancy concluded that pumping recycled water via a pipeline so as to irrigate new lands was not a viable option from a national economic point of view. Note should be taken of frequent Government statements that economic growth through efficient undertakings is one of its prime objectives. Consequently, we agreed to eliminate highland options (HL#2, 2a, and 2b) on purely economic grounds. To the extent that the Government wishes to provide farming opportunities through the provision of recycled water, far better options can be found in the Jordan Valley, where land remains under utilized and water can be made available without pumping--the Northern Option (JV#3) excepted.

As a point of reference, the Groundwater Management portion of the ARD contract explored several options for developing new fresh water sources and protecting the aquifer from which the Amman-Zarqa basin receives its municipal water supply. One of these sources is fossil water from Disi, mentioned in the 1997 World Bank and Fitch (2001) reports. The estimated cost of this water comes to 708 fils per cubic meter, including the cost of constructing the pipeline, pumping the water, and maintaining the line. At the other extreme, mentioned in the Fitch report, is the low cost of a farmer buy-out program. About 30 percent of the farmers interviewed by the Groundwater Management team said they would be happy to have the Government buy out their wells. Assuming that many of these farmers are finding it difficult to make a profit because of the increasing pumping costs and increasing salinity of the water, the economic cost to the economy of stopping this agricultural use of groundwater is at or close to zero. True, the Government would have to compensate these farmers, probably with some form of cash payment, but this would be a *transfer payment*, much the same as those associated with social programs for public education and health. The reader may want to keep these two values (zero or near zero and 708 fils per cubic meter) in mind when reading about the cost of water associated with the options soon to be considered.

The following sections contain a summary of this consultancy=s analytical findings. They include 1) a section on methodology, 2) consideration of five options for making additional fresh water available,[4] 3) an option that promotes industry, 4) profitability of agriculture in the Jordan Valley, 5) consideration of five options that provide recycled water to farmers, [5] 6) concepts to consider when forming alternative scenarios out of the acceptable options, 7) conclusions, and 8) an appendix with tables supporting the profitability of Jordan Valley agriculture.

Methodology

The approach to economic analysis used in this report relies on *annualized* values for estimating Government costs of water delivery and farmers= costs for on-farm investment. We assumed a 40-year investment lfe, periodic replacements, and a Asocial@ discount rate of ten percent[6] We start with investment costs for water delivery and on-farm facilities that are essentially in present worth terms then adjust the costs downward to allow for various savings in he net present worth (NPW).[7] We then convert the adjusted values to an *equivalent annual worth* using standard benefit-cost techniques.

For evaluating options that free up fresh water, the resulting measure of interest is *fils per cubic meter delivered* to the Amman-Zarqa watershed and of suitable quality for potable consumption..

[4] The relevant fresh water options are Northern Directorate (JV#3), Wadi Dhuleil (HL#3), Greater Wadi Dhuleil (HL#3a), Highlands Irrigation Distribution Network (HL#4), and Industrial Area (HL#4). For details, see for example WMI/ARD (April 2001).

[5]The relevant recycled water options are Northern Directorate (JV#3), Middle Directorate (JV#2), and Karameh (JV#1).. For details see, for example, WMI/ARD (April 2001).

[6]. The Fitch report relies on a 30-year analysis period. We believe that 40 years more nearly reflects the effective life of most water-delivery facilities, assuming proper maintenance and periodic replacements. The difference between our two assumptions is marginal.

[7] The standard engineering estimates employed by ARD engineers include market land values, financial contingencies, and a summation of costs that implies no construction periods. Correcting for these, using results from my earlier report (Shaner, 2000) yielded a NPW 30 percent lower than contained in the source material. This explains the 30 percent reduction in investment costs that the reader will see in some of the tables. The reader will also see two other figures--23 percent and 15 percent--as deductions to the infrastructure costs. These represent adjustments to place the stream of costs on a comparable basis with estimated stream of municipal water made available in the Greater Amman-Zarqa Basin. The plus 50 percent added to farm investment reflects frequent replacements for the shorter-lived on-farm assets. Our reasoning in taking this Aadjustment@ approach was simply to save time by not having to develop the standard cash-flow analyses. Given the great differences in magnitudes of some of the costs, we thought this approach reasonable.

Delivery is a major cost for the Northern fresh water option, but not for highland options. On the other hand, treatment costs (due to high salinity levels) are of major significance for some of the highland options, but not for the Northern fresh water option. Given the extreme importance of potable water to the Jordan economy, this measure (fils/cubic meter) serves as a *numeraire*, which in theoretical economics is the item to be optimized either through cost minimization as in the present case, or as an item generally to be maximized, as when wishing to use investment capital efficiently.[8] However, using this measure of water, which includes its location and quality, does not imply that the fresh water saved must be pumped. Deciding whether to use the water directly for consumption, with the implied treatment requirements, is a groundwater management decision that falls outside the scope of this report.

For evaluating options that provide recycled water to farmers, the measure of interest is *net annualized net revenues*. The measurement could just as well have been in terms of NPW; but the measure of benefits was already in a ready and suitable form.

When Government investments are concerned, we evaluated the project from the *national* perspective. Should the results prove positive, the question remains as to whether farmers would be interested. To gain insight into this question, we estimated net farm returns with most of labor costs removed. The results would be essentially in terms of returns to family labor and management that can then be compared with what is considered an acceptable income for a rural family. We applied this approach for the Karameh option.

Finally, a reader of my earlier report (Shaner, 2000) will note that I used a *rate of return* measure, rather than either the *annualized net returns* or *NPW*. While procedures are slightly different, when carried out properly, they lead to similar decisions. An advantage of the *rate of return* method is that non-economists have an intuitive feel for the results. In the present case, our reliance on *annualized* values has the advantage of showing net income that farmers might earn on their land--whether owned or rented.

Options that Free-up Fresh Water

As already noted a major concern to Jordan is the provision of potable water for a growing population. Consequently, the ARD staff has given careful attention to those options that potentially could free-up fresh water for Amman-Zarqa Basin residents. Of the following five options only the Northern Directorate one provides large quantities of water at unit costs considerably lower than the Disi source; however, farming activities in the Northern Directorate will be disrupted. These conclusions flow from the analysis, which follows.

[8] Gittenger of the World Bank describes *numeraire* as A. . . the unit that measures the objective being maximized. Usually in project analysis, the objective is to maximize returns to capital.@

Northern Directorate (JV#3)

Characteristics: Construction and operation of a gravity pipeline that would carry recycled water from the King Talal Reservoir (KTR) to the upper reaches of the Northern Directorate. The diversion point is along the Wadi Zarqa at an elevation of some 100 m above the valley floor. This option's intent is to substitute 57.0 MCM in the near future, which would be pumped to the Zai treatment plant for municipal use via a pipeline with this capacity that is currently under construction and scheduled for completion next year. For the time being, the gravity line's surplus capacity of about 12,000 MCM cannot be delivered to Amman, which means that this same quantity of fresh water could still be used in the Directorate. We assume that irrigating with recycled water would cause local farmers to gradually move out of their concentration on citrus, since this crop requires low-saline water to perform well, and into cropping patterns typical of those found in the Middle Directorate. Accordingly, we have assumed that farming the 57,000 dunums with recycled water would lead to lower net revenues per dunum. We have also assumed that those who continue to receive fresh water would find their yields reduced, but only slightly. Table 1 provides the details.

Investment & Operating Costs: The estimated design and construction cost of the 67 km gravity recycled water pipeline is JD87,2 million, its annual O&M cost at 1.5 percent of investment cost is estimated at JD1.3 million; the estimated annual cost of pumping the fresh water to Zai and maintaining the line (O&M) is JD11.1 million. Farmers' investment in drip facilities (mainly filters, booster pumps, and filter lines) would be JD11.8 million. Annual cropping losses of JD3.9 million result from 1) the switchover from fresh water to recycled water for those on the 57,000 dunums and 2) from reduced yields for those on the other 12,000 dunums who are still able to receive fresh water, but at a lower level of certainty.

Results: These figures combine to produce a cost of good-quality fresh water delivered to Zai of 426 fils per CM. No account was taken of the investment cost of the fresh water pipeline from the off-take point on the KAC to the plant at Zai, is that the line is already under construction and, consequently, is what economists call a *sunk cost*. Were it to be included, the cost would rise to 529 fils per CM. Table 1 shows the calculations, as well as more detail.

Table 1. Freshwater Cost for Northern Pipeline Option (JV#3)* - National Perspective

Freshwater diverted, MCM /yr 57.0			
Areas relying on recycled water, dunums 57,000			
Areas continuing to use freshwater, dunums 12,000			
Total area, dunums 69,000			
--- Costs ---------------------------------------			
			Annual
			Equivalent
Item	--------- Investment	-------	@ 10 % dis.
	JD /dunum	JD '000	JD '000
Pipeline investment		87200	
Adjustment to pipeline @ - 23 %		-20056	
Filters, controls **	38		
Drip lines for vegetables **	67		
Sum	105		
Adjustment @ + 50 %	53		
Tree clearance, field leveling, contouring	50		
Total on-farm	208	11828	
Total investment		78972	8079 ***
----------------- Effects on net revenues to agriculture -----------------			
Ten percent reduction in net revenues due to less secure water for the			
freshwater users: 10 % x existing net revenues			
0.1 217 12000			260
Income loss due to lower net revenues by switching to recycled water			
' (compares net revenues of the Middle Directorate with that of Northern)			
217 - 154 63 57000			3591
Sum of two agricultural losses			
Pipeline O&M @ 1.5% of pipeline investment			1308
Pumping cost on existing line to Amman @ 10 that of HL #2a			7063
Marginal pipeline O&M on existing line to Amman @ 140 % of pumpin			4000
Total			24301
Cost, fils /CM			**426**

* N.B. Investment costs for the pipeline that would carry freshwater to are omitted because the pipeline already has been built.. The resulting cost of freshwater, at 430 fils /CM, is therefore uniquely low and not representative of costs of providing water in this way.

** That one half of the on-farm investment can be salvaged and therefore not require replacement.

*** Conversion factor @ 10 %, 40 yrs = 0.1023

Results if investment cost of pipeline from KAC to Zai were included

Pipeline investment	67500	
Adjustment to pipeline @ - 15 %	-10125	
Net	57375	5869
Total that includes pipeline investment from KAC to Zai		30171
Cost, fils /CM		**529**

Wadi Dhuleil (HL#3)

Characteristics: This option would deliver recycled water via pipeline to an area 14 km east of As Samra for the purpose of conserving 2.5 MCM of fresh water currently being used to irrigate some 2,100 dunum. This irrigated area is part of the Dhuleil Irrigation project that provides farmers with groundwater pumped from deep wells, delivered to a storage reservoir, and distributed to their fields. The system once served a larger area that includes 8,000 irrigable dunum, but has been cut back to its present size because of a falling aquifer and increased salinity of the pumped water, which approximates 2,500 mg/lt. Based on the desalination process local industry uses, the cost of bringing the salinity level down to that acceptable for municipal use is 500 fils per CM. No further pumping is required to deliver the fresh water to a treatment plant, since the water either would be consumed locally or in the Amman area, which is roughly at the same elevation. The result is a high unit cost of fresh water for a relatively small amount. On the other hand, if the option were undertaken, farmers would benefit because of the lower salt content of the recycled water. Their yields should increase slightly for the fruit trees (mainly olives) they own and more so for the vegetables they grow, which means farmers ought to support the option, unless problems of health and possibly clogged drip lines are offsetting.

Investment & Operating Costs: Pipeline investment would be JD6.6 million, after adjusting for land, contingencies, and timing.. No on-farm investment would be required, since no new areas are being developed. Pipeline O&M at 5.0 percent of pipeline investment comes to JD470,000 per year. And annual pumping costs for the recycled water are estimated at JD67,000. Farmers income would increase by an estimated JD42,000 per year, thus offsetting slightly the pipeline costs. And no costs of pumping fresh water for use in the Amman-Zarqa Basin is thought to be needed. However, desalination is the largest cost by far.

Results: The total annual cost of this scheme, net the small savings to farmers, is JD1.2 million, which for 2.5 MCM per year equals 467 fils/CM. Add on 500 fils/CM for the required treatment for municipal use and the total becomes 967 fils/CM. Table 2 shows these results and how we derived them.

Table 2. Freshwater Cost for Wadi Dhuleil (HL#3) – National Perspective

Cropped area, dunums	2100				
Freshwater diverted, MCM/yr	2.5				
---Costs---					
			Annual		
			Equivalent		
	----------Investment -----		@10% dis.		
Item	JD/dunum	JD'000	JD'000		
Pipeline investment		9400			
Adjustment to pipeline @ - 30%		-2820			
Net pipeline		6580	673	*	
Increase in yields	20		-42	**	
Pipeline O&M @ 5% of pipeline investment			470		
Pumping for delivery of recycled water			67		
Pumping cost for freshwater delivery system			0		
Total			1168		
Cost per CM of freshwater					467
Desalination of municipal water (salinity level of 2,500 mg/lt)					500
Cost, fils/CM					967

* Conversion factor @ 10%, 50 yrs = 0.1023

** Because of the better quality of recycled water, yields are expected to go up by roughly 5% for tree corps (mainly olives) and 25% for vegetable crops, based on values for HL #2a (Shaner, 2000).

Greater Wadi Dhuleil Area (HL#3a)

Characteristics: This option modifies the preceding one (HL#3) by expanding the area to include farmers who pump about 7.0 MCM of water annually. ARD=s computer files show that water from these wells contain roughly 1,000 mg/lt, which makes its quality relatively good and means that it could be combined with other municipal water without further treatment. Together with the 2.5 MCM of lower-quality water of the HL#3 area, the overall cost of treated water, ready for municipal use, is 130 fils/CM. Water pumped from Government-owned wells in the area feeds into a distribution system that could, as would be the case with HL#3, serve either the local area or Amman. And, as with HL#3, this option would not incur pumping costs to deliver the fresh water to a municipal treatment plant. With the same qualifications as above, farmers ought to support this option because they would pay a recycled water charge that is considerably less than their current pumping costs, estimated at 70 to 100 fils per cubic meter.[9]

[9] This larger figure comes from Dr.Radaideh, who owns a farm in the Highlands and is a member of ARD staff.

Investment & Operating Costs: Pipeline investment would be JD24.4 million, after adjusting for land, contingencies, and timing.. No on-farm investment would be required, since no new areas are being developed. Pipeline O&M comes to JD1.7 million per year and annual pumping costs for the recycled water are estimated at JD275,000. Farmers income would not increase because water qualities are similar. No delivery costs to a treatment would be incurred. And, as above, desalination is the largest cost item.

Results: The total annual cost of this scheme is JD4.5 million. When divided by the fresh water saved, the unit cost is 476 fils/CM. Add on 130 fils/CM for the required treatment and the total becomes 606 fils/CM. Table 3 shows these results.

Table 3. Freshwater Cost for Greater Wadi Dhuleil Area (HL#3a)

Cropped area dunums	7900			
Freshwater diverted MCM/yr	9.5			
----- Costs -----				
			Annual	
			Equivalent	
	---------Investment----		@10% dis.	
Item	JD/dunum	JD'000	JD'000	
Pipeline investment		34927		
Adjustment to pipeline @ - 30%		-10478		
Net pipeline		24449	2501	*
Reduction in yields			0	
Pipeline O&M @ 5% of pipeline investment			1746	
Pumping for delivery of wastewater			275	
Pumping cost for freshwater delivery syste			0	
Total			4522	
Cost per CM of freshwater				476
Desalination of municipal water (salinity level of 1,000 mg/lt)				130
Cost fils/CM				606

* Conversion factor @ 10%, 50 yrs = 0.1023

Highlands Irrigation Distribution Network (HL#4)

Characteristics: An area labeled HL#4 that would serve an existing irrigated area some 35 to 40 km northeast of As Samra; estimates have not yet been made of the irrigable area, although it is considered extensive given current irrigation activity in the area; the water source is from deep wells operated primarily by large farmers who grow a variety of fruit, vegetable, and field crops.

Investment & Operating Costs: Not estimated because of the ARD team's belief that the option carries too many points against it to justify making the calculations. The reasons for reaching this conclusion include:

Results: None.

Industrial Area (HL#1)

Characteristics: This option involves building a pipeline that pumps recycled water 17 km to the Hashemite-Zarqa-Rusefieh (HRZ) area where it would be stored and then delivered by spur lines to a few principal locations. The new power plant and the refinery would use the recycled water for industrial cooling, with an annual demand of 5.5 MCM and 3.9 MCM, respectively. Lesser annual demand could come from the East Zarqa Planning Area (2.0 MCM), other industry (1.0 MCM), and the existing power plant (0.6 MCM). These amounts total 13.0 MCM that would otherwise be pumped from the underlying aquifer (MWI/ARD, April 2001). The quality of water from this aquifer ranges from 1,800 for the existing power plant to 2,500 mg/lt for the refinery. Both levels are considerably above the threshold level of 500 mg/lt desired to avoid scaling, microbial growth, and other system fouling. As a result, these users resort to reverse osmosis--an expensive process. Besides saving 13 MCM of fresh water annually, this option has an advantage in that industry can afford to reimburse the Government for the full cost of recycled water and appears willing to do so, provided the recycled water is treated to industrial specifications. While total expenditures, say for the new power plant, would be substantial, as a percent of total production costs, the amount is small.[10] By contrast, the Government would not expect farmers, especially small-scale operators, to pay a water charge that covers the full cost of a pipeline or other delivery system. In this sense, this industrial use of recycled water provides a substantial fiscal benefit.

Investment & Operating Costs: Pipeline investment, after adjustment, comes to JD11.2 million. Annual O&M and pumping costs, as estimated by the MWI/ARD report (April 2001), are JD 478,000 and JD138,000, respectively. The As Samra cost of treatment before delivery to the industrial area remains to be worked out; so, for purposes of this analysis, we have picked 250 fils per cubic meter as the cost of treatment required to meet industrial specifications. The costs of pumping from wells and subsequent treatment, whether for industrial cooling or municipal consumption, are essentially the same and need not enter into the imputed cost of potable water; and no costs of delivering water to a treatment plant in Amman would be necessary because the industrial area lies above the plant.

Results: The annualized cost of pipeline investment plus annual O&M and pumping costs come to JD1.8 million, which for 13 MCM per year equals 136 fils/CM. Add on 250 fils/CM for the required treatment at As Samra and the total becomes 386fils/CM. See Table 4.

[10] At 5.5 MCM annually, which is the amount of cooling water required by the new power plant, and at a unit cost of, say, 400 fils/CM, the plant would pay JD2.2 million per year--a sizable amount. But compared with the plant=s overall operating costs, the percentage is small. Rough calculations suggest that the percentage of cooling water cost to total plant cost could be on the order of two percent.

Table 4. Freshwater Cost for Industrial Area (HL#1)

Item	Investment JD'000	Annual Equivalent @10% dis. JD'000		
Freshwater diverted, MCM/yr 13				
---------------------------------------Costs------------------------------				
Pipeline investment *	13222			
Adjustment to pipeli -0.15	-1983			
Net pipeline	11239	1150		* *
O&M *		478		
Pumping of recycled water to the industrial site *		138		
Pumping cost for freshwater delivery sys		0		
Total		1766		
Cost per CM of freshwater			136	* *
Treatment of recycled water to meet cooling specification			250	
Total costs @ fils/CM			386	

* MWI/ARD, April 2001, p. 16.
* * Conversion factor @ 10%, 50 yrs = 0.1023

An Option that Provides Recycled Water to Industry

As a general rule, the Government will want to give priority to the use of recycled water whenever it frees up fresh water. Next on the hierarchy of importance is Jordan's use of recycled water for industry that does not offer this fresh water opportunity. As suggested in the foregoing section on option HL#1 (Industrial Area), the value of water to industry is considerably higher than that for agriculture, partly because the amount of water required is less than in agriculture, partly because industry usually contributes more output per unit of input (including water), and partly because of industry's key role in a country's development strategy. This does not mean that agriculture is not important. It has its place as a provider of considerable employment for the relatively unskilled and in reducing the country's dependence on imported foodstuffs. The point in this section is that a relatively small amount of water reserved for industry can yield considerably more economic benefit than if it were added to the already large quantities being used in agriculture. Administratively, this means that the Government should favor industry's claim to recycled water over agriculture's claim as long as recycled water requires allocation.

Profitability of Agriculture in the Jordan Valley

Data are available for irrigated agriculture in the Jordan Valley, but not in a form that gave us the information needed to evaluate the options for the directorates. What we wanted was net revenues by directorate from the national and farmers' perspectives. Appendix A contains the tables by which we generated the required information using cropping patterns reported for 1997 and cropping yields and prices for the three years of the Forward Study, namely 1995 to 1997.

Our findings show the following results for the three directorates in terms of annual net revenues per dunum. As noted earlier, the differences between the two perspectives is that the farmers= perspective does not contain labor for transplanting and routine tasks, and only one-third of the harvesting labor (except in the case of cucumbers because of the large quantities involved).

	Northern	Middle	Karameh
	----------------JD/dunum------------------		
National Perspective	217	154	106
Farmers= Perspective	269	263	179

The national values, which do not include the labor adjustment, fall in line with general expectations about the relative profitability of agriculture for the three directorates. The higher returns in the Northern Director are due to a combination of good soils and water and the relatively high returns to citrus. Values for the Middle Directorate are heavily weighted by the large percentage of the area in vegetables. And the Karameh Directorate was influenced by the shortages of water during the latter half of the cropping year. What is striking about the relationships among the three directorates when looking at net revenues from the farmers= perspective is the extent to which returns in the Middle Directorate approach those in the Northern Directorate. But of course, labor is a much larger component of cropping costs for vegetables than for citrus. Moreover, the higher cropping intensity in the Middle Directorate accentuates the impact.

The returns to vegetables vary widely according to the number and type of vegetables the Forward study reported as finding in each of the Stage Offices. To give an example, the only vegetable shown in the report for Stage Office Ten was eggplant, which produced a loss for the years reported; tomatoes was the only crop reported for Stage Office Nine, which produced a modest return; and Stage Office Five showed a mix of five vegetables and much higher net revenues, partly because of the extremely high yields and profits of cucumbers. Moreover, the impact on directorate-wide averages depended heavily on the percentage of vegetables grown. The percentage was the highest, leading to a high cropping index, in the Middle Directorate and a low percentage in the Northern Directorate, producing a low cropping index there. (The interested reader can find these results in the tables of Appendix A.)

Options that Provide Recycled Water to Farmers

As will be discussed in the section on scenarios, recycled water will become increasingly available as consumption of municipal water in the Amman-Zarqa Basin expands. By the target year 2025, recycled water should be plentiful. But for now, recycled water is a precious commodity, especially among farmers in Karameh District--i.e., those at the tail end of the King Abdullah Canal. Of the five options in this section, the Government must build delivery facilities only for the Northern, Karameh, and recharge ones. (The characteristics of the Northern option are the same as discussed above, but the analysis is different.) Because of the Government investment for these options, the analysis is taken from the national perspective. The other two options (Middle Directorate and Wadi Zarqa) do not require Government investment, so the perspective is that of the farmers.

Northern Directorate (JV#3)

Note: the earlier analysis of this option *combined* two investment decisions--one that delivered fresh water to the Zai plant and another that delivered recycled water to District farmers. The two are only one-way independent. That is, fresh water can be diverted to Amman, whether or not the recycled water line is built to compensate farmers for their loss of fresh water; or, they can be left with a greatly diminished fresh water source (i.e., 12 MCM/yr instead of the current 69 MCM/yr). The other option, of providing recycled without the diversion of fresh water to Amman is not a realistic option. Because of the described independence of alternatives, this analysis looks at whether or not the recycled water line can be justified economically. If not, and the Government decides not to invest in the recycled water line, the cost of fresh water (fils/CM) would be reduced considerably, but with considerable disruption in the lives of local farmers.

<u>Characteristics and Investment & Operating Costs</u>: Same as that described under the fresh water version.

<u>Results</u>: This option loses JD609,000 per year, assuming farmers switch to cropping patterns similar to those in the Middle Directorate and earn a comparable return (i.e., JD154/dunum). Based on 57,000 dunums, the shortfall is only JD11/dunum, or only 7 percent--well within the margin of error of these estimates. With so much at stake politically and socially, should the Government deprive Northern farmers of water they traditionally have come to expect, deciding not to build the delivery line is unrealistic. On this basis, the fresh water cum recycled water option stands as originally conceived, and the derived cost of fresh water at 426 fils/CM remains intact. See Table 5.

Table 5. Profitability of Northern Pipeline Option (JV#3), National Perspective

A comparison of alternatives recycled water delivered to the Northern Directorate with the gravity line against that which would prevail if the line were not built and farmers in the Directorate were left with only the 12.0 MCM per year of freshwater remaining after the 57.0 MCM per year is diverted to Amman. To simplify the calculations, assume that farmers use this smaller amount of water on a proportionally smaller amount of land as efficiently as they would the recycled water. In reality, the recycled water is likely to be more reliable, but because of its poorer quality yields could be less. These two possibilities tend to offset each other.

Cropped area, dunums			
without option, freshwater supply	69000		
with option, freshwater supply	12000		
with option, recycled water supply	57000		
------------ ------------ ----------------Costs--- ------------ ------------------			
			Annual
			Equivalent
	---------Investment-----		@10% dis.
	JD/dunum	JD'000	JD'000
Pipeline investment		87200	
Adjustment to pipeline @ - 23%		-20056	
Filters, controls	38		
Drip lines for vegetables	67		
Sum	105		
Adjustment @ + 50%	53		
Tree clearance, field leveling, contouring	50		
Total on-farm for 69,000 dunums	208	11828	
Total investment		78972	8079 *
Pipeline O&M @ 1.5% of pipeline investment			1308
Total system costs (government and private)			9387
Annual net revenues on 57,000 dunums	154		8778
Net present value			**-609**

Breakeven point requires only a 7% increase in net revenues, i.e. to JD 165/dunum. Given the wide range in net values from crop-to-crop and Stage Office-to-Stage Office, such a small increase is quite possible.

* Conversion factor @ 10%, 40 yrs = 0.1023

Middle Directorate

Characteristics: As is commonly known water shortages, especially south of the Northern Directorate have restricted production. The current year is a prime example. Were additional recycled water made available to Middle Directorate farmers, ARD staff believe cropping intensities would increase; and, given existing delivery capacity from KAC, no Government investment would be required. After reviewing data on the area, ARD staff concluded that the Directorate could beneficially use another 6.0 MCM per year.

Investment & Costs: No additional investment; only minor increases in operating costs, if any.

Results: The following analysis supports the opportunity to use 6.0 MCM of recycled water annually and suggests that applying it to vegetable production is a suitable option. Our reasoning follows:

- Vegetables in this Directorate take up more irrigated area than any other crop and show diversity of options as well. One can use data from App.Tables 1 to 3 show that the irrigated area devoted to vegetables in the Middle Directorate is greater than in the other two directorates: 41 percent, compared with 13 percent in Northern and an average of 21 percent in Karameh (SO6 and SO10). App. Tables 11 to 16 also reveal the greater diversity of cropping in the Middle Directorate.[11]

- By bringing the lowest of the three seasonal plantings up to the average of the other two seasonal plantings (using data from App. Table 2), 6,300 additional dunums of irrigated area could be planted in vegetables each year, which at 1,000 CM per dunum, is essentially the figure proposed in the ARD report.

- The farmers= perspective is relevant in this case (i.e., no Government investment), which means that net seasonal revenues would be JD122 per dumun, giving a total annual net revenue of JD2.2 million--less any minor investments the farmers must make.[12]

Thus, this option qualifies as a strong contender for additional recycled water when it becomes available in the Valley.

Karameh Directorate (JV#1)

Characteristics: By being at the tail end of the KAC system, Karameh farmers in SO6 and SO9 frequently do not receive the water they need, especially during the second half of the calendar year. They certainly do not have as much water as those further up the system. Or, when they do receive ample supplies of water, it would be during the rainy season when water is abundant. The result is generally lower yields and cropping intensities than for the other two directorates[13]--an effect that

[11] The SO=s in the Middle Directorate average nearly five out of the seven vegetables listed in the Forward report, compared with 3.5 crops for the Northern Directorate and less than two for the Karameh Directorate.

[12] We obtained this value by taking the single season value for vegetables of JD122/d. (App.Table 14) and multiplying it times 3 seasons/yr times 6,000 d., to give JD2,196,000/yr.

[13] Data from AppTable 7, show that yields of vegetables in SO6 are 80% of those in SO1 and SO2; the result for wheat is 41% and for citrus 31%; yields for bananas are the same. Lower yields are expected for citrus (Grattan, 2000) because of salinity, and low yields for other crops are

explains the low net revenues for Karameh farmers. To help overcome this water shortage, farmers frequently pump from shallow ground wells, which produce saline water, and compete for drainage water. Concern over the dangers of coliform pollution and the clogging of drip lines apparently is outweighed by their desire for more, less saline water. Thus, reports about farmers in these two SO=s welcoming more recycled water comes at no surprise. Farmers in SO10 currently receive fresh water from Kufrein dam, Wadi Hisban, and shallow wells. Responding to this situation, the Karameh option is to construct a 5.5 km pipeline to deliver water to SO10 farmers and to allocate sufficient recycled water via KAC to meet the annual irrigation requirements of farmers in these three SOs. The result is an additional 34,000 dunums of new irrigation and an increase in cropping intensity on another 5,600 dunums. In keeping with general practices in the area, we estimate farm size to be 36 dunums, which means 1100 farmers would benefit from this option. In estimating benefits for the option, we assume annual net revenues per dunum to equal those obtained in the Middle Directorate, once Karameh farmers receive an adequate allocation of water.

Investment & Operating Costs: The estimated design and construction cost of the 5.5 km pipeline is JD1.5 million, its annual O&M cost at 5.0 percent of investment cost would be JD108,000, and annual pumping costs are estimated at JD50,000. Land owners on the 34,000 dunums of new areas are assumed to invest JD2.7 million for the full range of needs listed for HL#2a (Shaner, 2000). We assume farmers who increase their cropping intensity would not have to invest in additional facilities; and that increased net revenues per dunum would be the same for intensification as for new lands. (In this case, we assume that intensification comes about by bringing into production land that has been fallowed for want of water.)

Results: The analysis from the national perspective reveals that this option would produce an annual surplus of JD3.1 million, making the Government=s investment highly attractive (see Table 6). This might be expected from the large amount of new land brought into production from a relatively small Government investment and the assumed on-farm investment. To evaluate the option=s impact on the participates, we have assumed 1) a land owner makes the investment, 2) the land owner prepares the land for cropping each year, 3) the share cropper pays for all inputs, including a water charge of 15 fils per dunum, and 4) the two split the net revenues evenly[14] Under these assumptions and the results from Table 6, we find the share cropper would make JD4,500 per year, which modestly exceeds the average rural family income for Jordan; and the land owner would make a 15 percent return on his investment. See Table 7. These results are probably in the range of being acceptable to both participants.

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likely due to water shortages.

[14] This is roughly the arrangement described by an Egyptian share cropper whom we met in Wadi Dhuleil last November.

Table 6. Profitability of Karameh (JV#1), National perspective.

Cropped area, dunums					
Increased cropping intens	5600				
New irrigated area	34000				
Total	39600				
Recycled water usage, MCM/yr					
Increased cropping intens	4.6				
New irrigated area	35.0				
Total	39.6				
Farm size, dunums	36				
Number of farms	1100				
---------------------------------Costs---------------------------------					
				Annual	
				Equivalent	
		---------Investment---		@10% dis.	
Item		JD/dunum	JD'000	JD'000	
Pipeline investment			2160		
Adjustment to pipeline @ - 30%			-648		
Net pipeline			1512	155	*
On-farm investment		513			
Adjustment fo on-farm @ + 50%		257			
Total on-farm (new irrigated area)		770	26163	2676	*
Pipeline O&M @ 5% of pipeline investment				108	
Pumping				50	
Total costs				2989	
Net revenues (same for intens & new areas)		154		6098	
Net present worth				**3109**	

* Conversion factor @ 10%, 50 yrs = 0.1023

Wadi Zarqa

This option, involving the Wadi Zarqa area, assumes the area's farmers might preempt an additional 3.3 MCM of recycled water that flows past their land. This acquisition would allow them to expand irrigation there from 17,000 dunums now irrigated to approximately 20,000 dunums--most likely for irrigating olive and other fruit trees and growing vegetables. They are likely to divert this water from the passing stream through diversion channels upstream or low-lift pumps, as they have in the past. ARD bases this 3.3 MCM estimate on evidence of past irrigated areas beyond those presently irrigated and on the anticipated response of Wadi Zarqa farmers to market demand should that be forthcoming. Thus, this option assumes no Government investment; instead, any development costs would be borne by the farmers themselves.

Table 7. Profitability of Karameh (JV#1), Perspective of a sharecropper & a landowner.

Cropped area, dunums				
Increased cropping intensi	4600			
New irrigated area	35000			
Total	39600			
Recycled water usage, MCM/yr				
Increased cropping intensi	4.6			
New irrigated area	35.0			
Total	39.6			
Farm size, dunums	36			
Number of farms	1100			
--				
			Annual	
			Amounts	
Item		JD/dunum	JD	
Net revenues from crop production		265	9540	
Less water charges		15	540	
Net returns from cropping			9000	
50-50 of net returns with landowner			4500	
Net returns to share cropper			**4500**	
Average income for a rural family of six to seven members*			**4044**	
--				
Profitability for the land owner			36 dunum	Total
Land owner's share			4500	
Less land preparation		2	72	
Net annual returns, years 2 - 40			4428	
Investment year "0"		385		13.86
year 1		385		13.86
Internal rate of return, %				**14.8**

* Dept of Statistics, Household Survey of 1997.

The farmers' practice of growing vegetables, largely for consumption in the neighboring Amman area, has caused the Government some concern. That concern relates to farmers' violation of Government regulation that prohibits use of recycled water for growing vegetables and limits its use on fruit trees when water could come directly into contact with the fruit. This violation, in turn, endangers public health as well as damages Jordan's ability to sell some of its agricultural products on the international market. Rather than proposing stricter enforcement of standards, which have not been particularly successful in the past, this option recognizes the farmers' interest and ability in using the recycled water that is so easy for them to access. That is, this report recognizes the reality of Wadi Zarqa use of recycled water and allows for this use when allocating future supply among the alternative options.

Groundwater Recharge in the Jordan Valley

During the winter months the Yarmouk River and KTR provide more water than farmers in the Jordan Valley Directorates can use productively. Farmers do apply some of it to leach accumulated salts from the soils, which is a productive use; but the rest passes through the KAC system without being used. With the right geological conditions this surplus water has the potential for being fed into the aquifer and pumped back up when water is in short supply--especially during the latter half of the cropping year and especially in the Karameh Directorate.

The report, Options for Artificial Groundwater Recharge (MWI/ARD, April 2001) looked into possibilities for recharging the aquifer, but did not make specific recommendations or settle on a particular design. Instead, the study=s author concluded that groundwater recharging had potential and deserved further study. Later, ARD engineers conceptualized a design involving a series of ditches running parallel with, and above, the KAC, assuming suitable granular outcrops can be found there. Construction could be low-cost, involving heavy earth-moving equipment; and operations might mean only low-lift pumping from KAC into the recharging ditches. For this design to work, water from the recharging ditches would need to flow subterraneously into the adjacent fields. Farmers could then pump water, as they now do, from this recharged aquifer. The lift is not large, perhaps 20 to 30 meters. However, the practicality of such a scheme remains to be seen. Limestone fractures, sink holes, or other factors could divert the recharged water away from its intended location. To gain insight into these possibilities, the Executive Summary of the cited report suggests a pilot program once follow-up studies are completed.

We concur with this suggestion, given the potential benefits that could be obtained. For instance, 1) reservoir quality could improve, given the lower salinity of KAC water, at 1,200 gm/lt, compared with 3000 gm/lt or higher of the water currently in the aquifer, 2) the recharged water would help maintain the aquifer level in the face of any increased pumping over time, 3) a second water source improves the certainty of water supply, which could lead farmers to increase cropping intensity and to grow higher-valued crops, and 4) as mentioned, the scheme ought to be a low-cost investment from the Government=s perspective, partly from the nature of the proposal and partly because farmers will likely be the ones investing in the wells and operating their own pumps.

Socially, the scheme could have a drawback in that the larger farmers (ones who could afford to drill wells and invest in pumps) would be the ones to benefit. But then, the Government might provide low-cost loans to the smaller farmers, help them organize themselves for investment in a well to be shared among the participants, or even develop a public pumping scheme. Experience of farmers, large and small, in Egypt and Pakistan show that they highly value using their own pumps to access water from the relatively shallow aquifers below the areas they cultivate. However, the experience with publicly-owned and operated pumping schemes in these two countries has often been discouraging.

Scenarios

This section begins by listing the results of the options described above, then suggests concepts for combining them into alternative scenarios for the Government=s consideration. Results are in terms of the amount of freshwater that might be saved, the imputed cost of freshwater, and the potential use of recycled water. Next is a look at the relationship between freshwater demand (i.e., for municipal use) and recycled discharges from As Samra, so as to put the options= results into perspective. Following this are principles for combining the options into *scenarios*, with a comment about actually making the choices.

Table 8, shows the results of this report=s analysis of options. The industrial area (HL#1) would provide freshwater at the lowest cost and put recycled water to its highest-valued use. Next in line, in terms of freshwater unit costs, is the Northern option (JV#3), which provides more freshwater than the other two options combined.[15] The greater Wadi Dhuleil option (HL#3a) is attractive on a unit cost basis, when compared with Disi. The Karameh option (JV#1) provides an ample source of demand for recycled water, which it could use profitably; and the Middle option (JV#2) generates somewhat lower annual net revenues, but without requiring Government investment.

Table 8. Option Results

Option	Fresh water saved MCM/yr	Unit cost fils/CM *	Recycled Wtr demand MCM/yr	Profitability JD'000/yr	
Industrial Area (HL#1)	13.0	386	13.0	---	
Northern Dir. (JV#3)	57.0	426	57.0	- 609	
Greater Wadi Dhuleil (HL#3a)	9.5	606	9.5	---	
Karameh Dir. (JV#1)	---	---	39.6	3,109	
Middle Dir. (JV#2)	---	---	6.0	2,200	
Wadi Zarqa (WZ#1)			3.3	---	* *
Hashemite Univ.			1.5	---	* *
Totals	79.5		129.9		

* Note: the cost of some buy-outs approaches zero from the national perspective, and the cost of water from Disi, according to the World Bank report (1997), is 708 fils/CM.
* * Profitability not estimated as part of this report, since the Government has limited control ove recycled water use in the Wadi Zarqa and has made a prior commitment to the Hashemite U

As should be obvious from the preceding paragraph, these options present the Government with a range of factors to consider when deciding on which of them to accept and in what order. Table 9, which relates freshwater (i.e., municipal) demand with As Samra discharges, can provide some guidance on the order of these options. The key components of Table 9 are 1) Jordan=s annual growth in population, estimated at 3.0 percent during the initial years, then slowing slightly, 2) the fixed percentage

[15] Note: the Wadi Dhuleil option (HL#3) and the Greater Wadi Dhuleil option (HL#3a) are mutually exclusive in that the latter contains the irrigated area of HL#3.

of the population residing in the Amman-Zarqa watershed, an assumption that probably understates the potential growth, 3) the accelerated increase in per capita water demand until 2010, as municipal water supply catches up with latent demand, and 4) the constant loss rate between water demand and recycled discharges. These increases in water demand and As Samra discharges set the parameters for choosing the options that would make up the scenarios.

Table 9. Freshwater Demand in the Amman-Zarqa Watershed and Recycled Discharges from As Samra.

Year	Total Population Jordan	Percent Amman-Za Watershed	Population Amman-Za Watershed	Water Demand l/cap/day	Water Demand MCM/yr	Water Demand Gwth Rate	Loss Rate Fresh to Reclaimd	As Samra Discharges MCM
1999	4900000	0.4	1951000	98	70		0.8	56
2000	5047000	0.4	2017334	100	74		0.8	59.1
2001	5198410	0.4	2085923	105	80		0.8	63.8
2002	5354362	0.4	2156845	111	87		0.8	69.6
2003	5514993	0.4	2230177	116	94		0.8	75.4
2004	5680443	0.41	2306004	123	104		0.8	83.2
2005	5850856	0.41	2384408	129	112	6.5	0.8	90
2006	6026382	0.41	2458324	129	116		0.8	92.9
2007	6207173	0.41	2534532	129	119		0.8	95.3
2008	6393389	0.41	2613103	129	123		0.8	98.2
2009	6585190	0.41	2694109	129	127		0.8	101.5
2010	6782746	0.41	2777626	129	131	6.34	0.8	104.7
2011	6978428	0.41	2858178	129	135		0.8	107.7
2012	7179756	0.41	2941065	129	138		0.8	110.8
2013	7386892	0.41	3026356	129	142		0.8	114
2014	7600004	0.41	3114120	129	147		0.8	117.3
2015	7819264	0.41	3204429	129	151	2.89	0.8	120.7
2016	8030384	0.41	3297358	129	155		0.8	124
2017	8247204	0.41	3392981	129	160		0.8	127.3
2018	8469879	0.41	3491378	129	164		0.8	130.7
2019	8698565	0.41	3592628	129	169		0.79	134.3
2020	8933427	0.41	3696814	129	174	2.7	0.79	137.9
2021	9175255	0.41	3796628	129	179		0.79	141.6
2022	9423629	0.41	3899137	129	184		0.79	145.5
2023	9678726	0.41	4004413	129	189		0.79	149.4
2024	9940729	0.41	4112533	129	194		0.79	153.4
2025	10209825	0.41	4223571	129	199	2.71	0.79	157.6

Comments:

Population of Jordan assumed to grow at 3.0 percent until 2010 and then to slow to the level shown for the growth in water demand.

The assumed rapid increase in per capita water demand over the next ten years results from pent-up demand and assumed increases in supply.

Losses between municipal water supply and recycled water discharges are assumed constant for want of better information.

Sources: Statistical Abstracts for 1999 population estimate, JICA for estimates of per capita water consumption, and MWI/ARD for estimates of the loss rate and the resulting discharges at As Samra. For the latter, see the Draft Interim Report, April 2001 (note: values shown above for 2000 and 2005 differ somewhat from those shown in the Draft Interim Report, but not for the other benchmark years).

Consider now the large size of the Northern option. Assuming this option would first begin pumping fresh water to the Zai plant in 2004, when the demand is shown to be 104 MCM, the additional 57 MCM would not be needed in its entirety until after 2017.[16] But unlike most investments,

[16] That is, 57 MCM added to the 104 MCM projected for 2004 equals 161 MCM which

which must wait for demand to materialize before they become profitable, the full amount of these deliveries from JV#3 could, conceptually at least, be applied immediately to satisfy Amman demand. The result would lead to a cutback in Highland pumping, thereby helping to preserve the Amman-Zarqa aquifer. However, this possibility is over-ridden by the lack of recycled water needed to replace the freshwater diverted from agriculture. Thus, availability of recycled water becomes the controlling parameter. Under this restriction, diverting NorthernÆs freshwater to Zai could not begin until 2015.[17]

Four factors influencing the sequence in which the options might be selected are 1) the amount of freshwater to free up (and by inference the size of the investment), 2) the cost per unit of freshwater saved, 3) the size of the net annual benefits from using recycled water, and 4) as just implied, the value to be place on aquifer conservation. Normally, the Alumpier@ an investment, the longer it will take to reach its full potential; and the longer the delay, the lower will be the annualized net benefits. But, as just noted, when freeing up fresh water, which can remain in the ground until needed, this disadvantage seems to disappear. When considering the NPW (or *annualized net revenues*) of future benefits and costs, a simplifying guide is to Atake your benefits as soon as possible and pay the costs as late as possible, *all else being the same.* Such guidance would favor, as initial investments, the lowest unit cost of freeing up freshwater: namely, the Industrial option (HL#1); and the Karameh option (JV#1) for use of recycled water.

Actually selecting the options according to the foregoing principles, as well as other guidelines the key participants and ARD may wish to add, is best left to the interested parties.

approximates the demand in 2017.

[17] Taking 2001 as the controlling year, with 63.8 MCM of annual discharge, and an annual replacement need of 57 MCM, a total recycled water supply of 120.8 MCM is not reached until 2015. For JV#3 to become operational, i.e., without cutting back on irrigation in the Northern Directorate, all additional recycled water would have to be allocated to JV#3.

Conclusions

It is not difficult to conclude that Jordan faces a serious problem in meeting the municipal water requirements of an expanding economy and a growing population. Consequently, this consultancy focused on evaluating those options whereby recycled water might realistically free up freshwater for municipal use.[18] Of the four options evaluated, only the Northern option (JV#3) provided the possibility of freeing up a large block of fresh water (i.e., 57 MCM annually). The next option in terms of freshwater supply was the Industrial area (HL#1), with the possibility of provided the possibility of freeing up a large block of fresh water (i.e., 57 MCM annually). The next option in terms of freshwater supply was the Industrial area (HL#1), with the possibility of making 13.0 MCM available annually. The Wadi Dhuleil option (HL#3a) would make an estimated 9.5 MCM of freshwater available annually. Implementing the Northern option means pumping water from the Jordan Valley to the Zai plant near Amman and constructing a gravity line to bring recycled water to Northern Directorate farmers. Implementing the Industrial option means treating recycled water to meet industrial standards. And implementing the Dhuleil option would require treating the freshwater to meet municipal standards. These costs are combined with other option costs to yield a cost of municipal water delivered to the Amman area of a quality suitable for municipal use of 386 fils/CM for the Industrial option, 426 fils/CM for the Northern option, and 490 fils/CM for the Dhuleil option--all considerably less than the Disi option at 708 fils/CM. Besides providing the lowest cost source of freshwater, the Industrial option also puts the recycled water it uses to the highest economic use by providing cooling water for the refinery, the existing power plant, and the planned power plant. Simply stated, water used for industrial purposes contributes far more than if it were used in agriculture.

Our analyses revealed that substantial quantities of recycled water can be put to profitable use in the Jordan Valley. Of the three areas, the Karameh option (JV#1) provides farmers with the greatest net revenue gain, at JD3.1 million per year. The profitability there results from the construction of a 5.5 km pipeline to SO10 and a combined increase in area cropped and intensified on 39,600 dunums. The Middle Directorate also benefits by increasing the net revenues of farmers who irrigate 6,000 dunums of land, entirely through crop intensification, by JD2.2 million annually. The advantage of the Middle Directorate is that it requires no additional investment by the Government. The Northern Directorate option (JV#3) actually loses JD0.6 million annually. But this estimated loss requires only a seven percent increase in net revenues per dunum to break even; and considering the freshwater benefits resulting from this option, as well as the disruption to the farming community there if recycled water were not provided, the recycled portion of this option also qualifies, in our opinion, for investment. In this case the Government=s obligation to existing farming activity overrides a relatively small loss in terms of national income.

[18] The Draft Interim Report (MWI/ARD, April 2001) judged that the Highlands Irrigation Distribution Network option (HL#4) had the potential of providing 20 MCM of freshwater annually, but considered that the value of production there using freshwater was too important to lose and the difficulties of implementation were too great to overcome. So, this consultancy did not look into the economics of this option.

Total annual demand for recycled water to be 129.9 MCM for the seven options listed in Table 8. Adding this total, which represents profitable use of this resource, to the current releases of 63.8 MCM from As Samra, which are also being put to profitable use, brings the total to 193.7 MCM. This figure far exceeds the anticipated releases by the year 2025 of 157.6 MCM, which means that *recycled water will be a scarce and value resource well into this century*.

We based the foregoing analysis of the profitability of the three Jordan Valley directorates on a build-up of net revenues per dunum for each of the Stage Offices. To do this we began with cropping areas, as developed by ARD staff. Then we relied upon Volumes II and V of the Forward report (June 2000) for yields, unit prices, and operating costs. We did this from both a national and farmers' perspective: the former to learn if an investment was in the national interest economically and the latter to learn if farmers would find it profitable to participate in the schemes. Our findings showed, as would be expected, the greatest net revenues per dunum in the north and the least net revenues per dunum in the south. The only difference between the two perspectives was the removal of most of the labor costs to obtain the farmers' perspective. The result gives essentially *returns to family labor and management*.

To sum up, recycled water can play an important role in freeing up freshwater for municipal use. The anticipated quantities so obtained, together with the Disi project, should cover Jordan's needs well beyond 2025. Recycled water also plays an important role for irrigation in the Jordan Valley by making it possible to intensify existing areas of production and expand production in other areas. Production there is profitable, provides employment, meets part of the country's food requirements, and earns foreign exchange by the export of its products. Finally, pumping recycled water uphill so as to expand agriculture into new areas is not an economic use of the country's resources.

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Appendix: Calculation of Net Revenue for Irrigated Agriculture in the Jordan Valley

This appendix contains 16 tables that cover revenues and production costs associated with irrigated crop production in the three Jordan Valley directorates. As mentioned in the text, our purpose in developing these tables was to have historical estimates of net revenues according to Stage Office. With such information on irrigation, productivity in the Northern, Middle, and Karameh Directorates can be compared and the results used in our evaluation of the options for using recycled water. We use the full costs of crop production in the analysis of options because we wish to know if an investment is in the national interest; similarly we use reduced costs of crop production to gain insight into possible farmer interest.

This analysis relied entirely on secondary sources, i.e., published and unpublished reports, based on previous field visits, and on Government records. Undoubtedly, conditions have changed from what they were several years ago when the primary data were collection. Nevertheless, we believe the data, which appear accurate and complete, to be the best available. As will be noted at the bottom of the tables, data sources are ARD for irrigated and cropped areas; Forward report, Vol. II, Annex C for cropping areas and yields; and Forward report, Vol. V for farm-gate prices and production costs.

The report on cropped and irrigated areas listed vegetables as a single category, which was inadequate for our purposes given the widely differing net revenues associated with different crops.[19] And the report on vegetable areas and yields was not comprehensive concerning cropped areas; for instance, only tomatoes are shown as being grown in Stage Office Nine and only eggplant as being grown in Stage Office Ten. Consequently, we combined information from the two sources. Another problem was the listing of fruit trees (separately from citrus) and nurseries. Because we lacked information about these two crops, we omitted them and expanded the areas of the other crops proportionally. Because of the relatively small areas involved, this procedure should not bias the results. While we believe our results to be representative of the value of crop production in the Valley, follow-up studies would be worthwhile. For instance, they could help in knowing if vegetable crop losses are widespread and extreme in some cases, as well as what action farmers take in response.

[19] For instance, the records show eggplant and squash as large losses, cucumbers as a large winner, and tomatoes as about average.

The order of the following tables accords with the way we arrived at our estimates of net revenues for each directorate.

C Table 1: Irrigated and Cropped Areas by Stage Office, Northern Directorate.
C Table 2: Irrigated and Cropped Areas by Stage Office, Middle Directorate.
C Table 3: Irrigated and Cropped Areas by Stage Office, Karameh Directorate.
C Table 4. Gross Revenues for Vegetables by Stage Office.
C Table 5 (two pgs). Crop Production Costs (by Stage Office), national perspective.
C Table 6 (two pgs). Crop Production Costs (by Stage Office), farmers= perspective.
C Table 7: Crop Rankings by Stage Office, national perspective.
C Table 8: Crop Rankings by Stage Office, farmers= perspective.
C Table 9: Overall Crop Rankings, national perspective.
C Table 10: Overall Crop Rankings, farmers= perspective.
C Table 11: Historical Net Revenues from Cropping in the Northern Directorate, national perspective.
C Table 12: Historical Net Revenues from Cropping in the Northern Directorate, faarmers= perspective.
C Table 13: Historical Net Revenues from Cropping in the Middle Directorate, national perspective.
C Table 14: Historical Net Revenues from Cropping in the Middle Directorate, farmers= perspective.
C Table 15: Historical Net Revenues from Cropping in the Karameh Directorate, national perspective.
C Table 16: Historical Net Revenues from Cropping in the Karameh Directorate, farmers= perspectve.

Appendix Table 1. Irrigated and Cropped Areas (dunums) by Stage Office Northern Directorate.

Stage No.	Patterns	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Stage1	Cropped area (Spring)	435	303	10,939	605	152	0	
Stage1	Cropped area (Summer)	297	94	11,063	607	155	0	
Stage1	Cropped area Autumn	251	101	11,063	607	155	0	
Stage1	Cropped area	983	404	11,022	606	154	0	13,169
Stage1	Irrigated area*	435	303	11,063	607	155	0	12,563
						Cropping intensity		1.05
Stage2	Cropped area (Spring)	44	20	13,270	256	893	16	
Stage2	Cropped area (Summer)	44	20	13,270	256	893	16	
Stage2	Cropped area Autumn	66	20	13,261	243	893	16	
Stage2	Cropped area	154	40	13,267	252	893	16	14,622
Stage2	Irrigated area*	66	20	13,270	256	893	16	14,521
					Cropping intensity			1.01
Stage3	Cropped area (Spring)	8,383	1,903	4,121	360	366	0	
Stage3	Cropped area (Summer)	734	225	4,393	360	370	0	
Stage3	Cropped area Autumn	7,400	225	4,393	360	370	0	
Stage3	Cropped area	16,517	2,128	4,302	360	369	0	23,676
Stage3	Irrigated area*	8,383	1,903	4,393	360	370	0	15,409
					Cropping intensity			1.54
Stage7	Cropped area (Spring)	5,294	2,361	15,844	1,093	1,568	487	
Stage7	Cropped area (Summer)	5,067	229	16,718	1,122	1,585	480	
Stage7	Cropped area Autumn	1	0	16,730	1,122	1,385	480	
Stage7	Cropped area	10,362	2,361	16,431	1,112	1,513	484	32,262
Stage7	Irrigated area*	5,294	2,361	16,718	1,122	1,585	480	27,560
Stage7					Cropping intensity			1.17

Totals	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Modified crped area**	9,339	2,467	45,022	2,330	0	0	59,157
Adjusted crped area***	10,892	2,877	52,513	2,718			69,000
Rounded values	10,900	2,900	52,500	2,700			69,000

* Taken as the largest of the seasonal areas.

** Taken as one-third for vegetables and one-half for cereals so as to simplify their use elsewhere; we omitted fruit trees and nurseries because our source material provided insufficient information about them.

*** Revised upward to match estimated irrigation in the Directorate.

Source: ADR Memo of 15/1/01 on Visit to the Jordan Valley, Table 2.

Appendix Table2. Irrigated and Cropped Areas(dunums)by Stage Office
Middle Directorate

Stage No .	Patterns	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Stage 4	Cropped area (Spring)	2,461	516	1,047	0	704	105	4,833
Stage 4	Cropped area (Summer)	5,100	1,002	1,047	0	626	86	7,861
Stage 4	Cropped area Autumn	8,600	750	1,054	0	621	86	11,111
Stage 4	Cropped area	16,161	1,266	1,049	0	650	92	19,219
Stage 4	Irrigated area *	8,600	1,002	1,054	0	704	105	11,465
					Cropping intensity			1.68
Stage 5	Cropped area (Spring)	1,072	442	1,911	115	1,088	37	4,665
Stage 5	Cropped area (Summer)	8,932	214	1,936	115	1,083	6	12,286
Stage 5	Cropped area Autumn	6,318	96	1,936	115	1,121	58	9,644
Stage 5	Cropped area	16,322	538	1,928	115	1,097	34	20,034
Stage 5	Irrigated area *	8,932	442	1,936	115	1,121	58	12,604
					Cropping intensity			1.59
Stage 8	Cropped area (Spring)	10,241	1,337	5,398	48	957	271	18,252
Stage 8	Cropped area (Summer)	1,177	340	5,424	48	987	289	8,265
Stage 8	Cropped area Autumn	8,029	8	5,355	48	957	289	14,686
Stage 8	Cropped area	19,447	1,345	5,392	48	967	283	27,482
Stage 8	Irrigated area *	10,241	1,337	5,424	48	957	271	18,278
					Cropping intensity			1.50

Totals	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Modified crp'ed area**	17,310	1,575	8,369	163	0	0	27,417
Adjusted crp'ed area***	27,149	2,469	13,126	256			43,000
Rounded values	27,150	2,500	13,100	250			43,000

* Taken as the largest of the seasonal areas.

** Taken as one-third for vegetables and one-half for cereals so as to simplify their use elsewhere; we omitted fruit trees and nurseries because our source material provided insufficient information about them.

*** Revised upward to match estimated irrigation in the Directorate.

Source: ADR Memo of 15/1/01 on Visit to the Jordan Valley, Table 2.

Appendix Table 3. Irrigated and Cropped Areas (dunums) by Stage Office Karameh Directorate

Stage No.	Patterns	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Stage 6	Cropped area (Spring)	5,323	459	1,554	47	3,197	26	10,606
Stage 6	Cropped area (Summer)	4,018	419	1,534	47	3,216	86	9,320
Stage 6	Cropped area Autumn	598	2	1,428	72	3,308	26	5,434
Stage 6	Cropped area	9,939	461	1,505	55	3,240	46	15,247
Stage 6	Irrigated area *	5,323	459	1,554	72	3,308	86	10,802
					Cropping intensity			1.41
Stage 9[1]	Cropped area	13,294	506	30	3,400	315	0	17,545
Stage 9	Irrigated area *	10,516	400	30	3,400	315	0	14,661
					Cropping intensity			1.2
Stage 10	Cropped area (Spring)	279	0	847	4,449	375	0	5,950
Stage 10	Cropped area (Summer)	279	0	847	4,440	375	0	5,941
Stage 10	Cropped area Autumn	279	0	847	4,449	375	0	5,950
Stage 10	Cropped area	837	0	847	4,446	375	0	6,505
Stage 10	Irrigated area *	279	0	847	4,449	375	0	5,950
Stage 10					Cropping intensity			1.09

Totals	Vegetables	Cereals	Citrus	Bananas	Fruit trees	Nursery	Totals
Modified crp'ed area**	8,023	484	2,382	7,901	0	0	18,791
Adjusted crp'ed area***	14,518	875	4,311	14,297			34,000
Rounded values	14,500	900	4,300	14,300			34,000

[1] (data for spring, summer, and automn were not available from the source.)

* Taken as the largest of the seasonal areas.

** Taken as one-third for vegetables and one-half for cereals so as to simplify their use elsewhere; we omitted fruit trees and nurseries because our source material provided insufficient information about them.

*** Revised upward to match estimated irrigation in the Directorate.

Source: ADR Memo of 15/1/01 on Visit to the Jordan Valley, Table 2.

Appendix Table4. Gross Revenues for Vegetables by Stage Office

Stage Office 1	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	4,900					1,500	3,172	
Value, fils/kg	50					97	46	
Gross rev, JD/dunum	245					146	146	209
Area, dunums	73					19	22	114
Gross rev, JD'000	18					3	3	24
Stage Office 2	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	4,900	2,253				1,500	3,122	
Value, fils/kg	50	137				97	46	
Gross rev, JD/dunum	245	309				146	144	240
Area, dunums	1,032	1,870				342	1,031	4,275
Gross rev, JD'000	253	577				50	148	1,028
Stage Office 3	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	4,059	2,240			10,500	3,076		
Value, fils/kg	73	137			178	30		
Gross rev, JD/dunum	296	307			1,869	92		578
Area, dunums	1,541	1,281			863	688		4,373
Gross rev, JD'000	457	393			1,613	63		2,526
Stage Office 4	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	3,977		592	1,675		3,076		
Value, fils/kg	73		313	79		30		
Gross rev, JD/dunum	290		185	132		92		226
Area, dunums	2,700		511	1,314		215		4,740
Gross rev, JD'000	784		95	174		20		1,072
Stage Office 5	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	3,808	2,182	696	1,624	10,500	3,076		
Value, fils/kg	73	137	313	79	178	30		
Gross rev, JD/dunum	278	299	218	128	1,869	92		385
Area, dunums	614	2,434	908	112	653	1,762		6,483
Gross rev, JD'000	171	728	198	14	1,220	163		2,494
Stage Office 6	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	3,377						2,830	
Value, fils/kg	73						46	
Gross rev, JD/dunum	247						130	188
Area, dunums	1,289						1,306	2,595
Gross rev, JD'000	318						170	488
Stage Office 7	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	4,900			656		1,500		
Value, fils/kg	50			79		97		
Gross rev, JD/dunum	245			52		146		146
Area, dunums	1,090			1,147		314		2,551
Gross rev, JD'000	267			59		46		372

Cont. Appendix Table4. Gross Revenues for Vegetables by Stage Office

Stage Office 8	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	3,977	1,979			10,290	3,076		
Value, fils/kg	73	137			178	30		
Gross rev, JD/dunum	290	271			1,832	92		601
Area, dunums	1,547	1,095			768	201		3,611
Gross rev, JD'000	449	297			1,407	19		2,171
Stage Office 9	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum	4,900							
Value, fils/kg	73							
Gross rev, JD/dunum	358							358
Area, dunums	45							45
Gross rev, JD'000	16							16
Stage Office 10	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Eggplant**	**Totals**
Yields, kg/dunum							2,830	
Value, fils/kg							46	
Gross rev, JD/dunum							130	130
Area, dunums							249	249
Gross rev, JD'000							32	32

Source: Forward, Vol. II, Annex C for areas and yields and Vol V . for value (farm-gate prices).

Appendix Table 5. Crop Production Costs, National Perspective (JD/dunum)

Stage Office 1	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92					20.00	3.33	0.00	0.00	2.96
Seed transplant'g	8.00					0	10.00	0.00	0.00	0.00
Manure	16.00					17.00	16.00	15.00	37.50	0.00
Chem fertilizer	27.89					24.62	28.01	63.60	46.30	0.61
Pesticides	58.00					45.00	61.00	33.00	0.00	0.75
Sacks	0.00					0.00	0.00	0.00	0.00	0.75
Mulch	20.40					20.40	20.40	0.00	0.00	0.00
Fuel & lubri	1.88					1.25	1.50	3.25	3.25	1.60
Labor, all other	22.50					32.00	45.00	31.00	55.00	1.05
harvest	27.50					28.00	30.00	10.00	10.00	0.00
Interest, wkg cap	14.96					14.25	16.19	29.85	29.97	3.76
Totals	204.05					202.52	231.43	185.70	182.02	11.48
Stage Office 2	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92	150.00				20.00	3.33	0.00	0.00	2.96
Seed transplant'g	8.00	0.00				0	10.00	0.00	0.00	0.00
Manure	16.00	24.00				17.00	16.00	15.00	37.50	0.00
Chem fertilizer	28.37	28.01				24.62	28.01	63.60	46.30	0.61
Pesticides	58.00	58.00				45.00	61.00	33.00	0.00	0.75
Sacks	0.00	0.00				0.00	0.00	0.00	0.00	0.75
Mulch	20.40	0.00				20.40	20.40	0		0.00
Fuel & lubri	1.88	1.25				1.25	1.50	3.25	3.25	1.60
Labor, all other	22.50	25.00				32.00	45.00	31.00	55.00	1.05
harvest	25.00	25.00				28.00	30.00	10.00	10.00	0.00
Interest, wkg cap	14.51	21.01				14.25	16.11	29.85	29.97	3.76
Totals	201.58	332.27				202.52	231.35	185.70	182.02	11.48

Cont. Appendix Table 5. Crop Production Costs , National Perspective (JD/dunum)

Stage Office 3	Tomatoes	Potatoes	Faba bean	Jew's Mal	Cucumber	Squash	Egg Plant	Citrus	Bananas	Wheat
Seeds	6.92	150.00			234.00	20.00		0.00	0.00	2.96
Seed transplant 'g	8.00	0.00			9.00	0		0.00	0.00	0.00
Manure	16.00	24.00			48.00	17.00		15.00	37.50	0.00
Chem fertilizer	27.89	28.01			123.98	24.62		63.60	46.30	0.61
Pesticides	58.00	58.00			430.00	45.00		33.00	0.00	0.75
Sacks	0.00	0.00			0.00	0.00		0.00	0.00	0.75
Mulch	20.40	0.00			20.40	20.40		0.00	0.00	0.00
Fuel & lubri	1.88	1.25			1.88	1.25		3.25	3.25	1.60
Labor , all other	22.50	25.00			180.00	32.00		31.00	55.00	1.05
harvest	27.50	25.00			155.00	28.00		10.00	10.00	0.00
Interest , wkg cap	14.51	21.01			107.30	14.25		28.59	29.97	3.76
Totals	203.60	332.27			1309.56	202.52		184.44	182.02	11.48
Stage Office 4	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92		18.00	13.00		20.00		0.00		2.96
Seed transplant 'g	8.00		0.00	0		0		0.00		0
Manure	16.00		16.00	0.00		17.00		15.00		0
Chem fertilizer	28.37		24.17	6.12		24.62		63.60		0.61
Pesticides	58.00		20.00	0.00		45.00		33.00		0.75
Sacks	0.00		0.00	0.00		0		0.00		0.75
Mulch	20.40		20.40	0.00		20.40		0		0
Fuel & lubri	1.88		1.25	1.25		1.25		3.25		1.60
Labor , all other	22.50		22.50	5.20		32.00		31.00		1.05
harvest	25.00		22.50	7.60		28.00		10.00		0.00
Interest , wkg cap	14.96		15.34	5.90		14.25		28.59		3.76
Totals	202.03		160.16	39.07		202.52		184.44		11.48

Cont. Appendix Table 5. Crop Production Costs , National Perspective (JD/dunum)

Stage Office 5	Tomatoes	Potatoes	Faba bean	Jew's Mal	Cucumber	Squash	Egg Plant	Citrus	Bananas	Wheat
Seeds	6.92	150.00	18.00	13.00	234.00	20.00		0.00	0.00	2.96
Seed transplant 'g	8.00	0.00	0.00	0	9.00	0		0.00	0.00	0.00
Manure	16.00	24.00	16.00	0.00	48.00	17.00		15.00	37.50	0.00
Chem fertilizer	28.37	28.01	24.17	6.12	123.98	24.62		63.60	46.30	0.61
Pesticides	58.00	58.00	20.00	0.00	430.00	45.00		33.00	0.00	0.75
Sacks	0.00	0.00	0.00	0.00	0.00	0		0.00	0.00	0.75
Mulch	20.40	0.00	20.40	0.00	20.40	20.40		0.00	0.00	0.00
Fuel & lubri	1.88	1.25	1.25	1.25	1.88	1.25		3.25	3.25	1.60
Labor, all other	22.50	25.00	22.50	5.20	180.00	32.00		31.00	55.00	1.05
harvest	25.00	25.00	22.50	7.60	155.00	28.00		10.00	10.00	0.00
Interest, wkg cap	14.96	21.12	15.33	5.96	107.30	14.72		28.59	30.44	3.04
Totals	202.03	332.38	160.15	39.13	1309.56	202.99		184.44	182.49	10.76

Source: Forward, Vol. V.

Cont. Appendix Table 5. Crop Production Costs , National Perspective (JD/dunum)

Stage Office 6	**Tomatoes**	**Potatoes**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92					3.33	0.00	0.00	2.96
Seed transplant 'g	8.00					10.00	0.00	0.00	0.00
Manure	16.00					16.00	15.00	37.50	0.00
Chem fertilizer	27.89					28.01	63.60	46.30	0.61
Pesticides	58.00					61.00	33.00	0.00	0.75
Sacks	0.00					0.00	0.00	0.00	0.75
Mulch	20.40					20.40	0.00	0.00	0.00
Fuel & lubri	1.88					1.50	3.25	3.25	1.60
Labor , all other	22.50					45.00	31.00	55.00	1.05
harvest	27.50					30.00	10.00	10.00	0.00
Interest , wkg cap	14.60					16.11	27.84	30.44	2.64
Totals	203.69					231.35	183.69	182.49	10.36
Stage Office 7	**Tomatoes**	**Potatoes**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92		13.00		20.00		0.00	0.00	2.96
Seed transplant 'g	8.00		0		0		0.00	0.00	0.00
Manure	16.00		0.00		17.00		15.00	37.50	0.00
Chem fertilizer	27.89		6.12		24.62		63.60	46.30	0.61
Pesticides	58.00		0.00		45.00		33.00	0.00	0.75
Sacks	0.00		0.00		0.00		0.00	0.00	0.75
Mulch	20.40		0.00		20.40		0.00	0.00	0.00
Fuel & lubri	1.88		1.25		1.25		3.25	3.25	1.60
Labor , all other	22.50		5.20		32.00		31.00	55.00	1.05
harvest	27.50		7.60		28.00		10.00	10.00	0.00
Interest , wkg cap	14.51		5.45		14.25		29.85	30.52	3.76
Totals	203.60		38.62		202.52		185.70	182.57	11.48

Cont. Appendix Table 5. Crop Production Costs , National Perspective (JD/dunum)

Stage Office 8	Tomatoes	Potatoes	Jew's Mal	Cucumber	Squash	Egg Plant	Citrus	Bananas	Wheat
Seeds	6.92	150.00		234.00	20.00		0.00		2.96
Seed transplant 'g	8.00	0.00		9.00	0.00		0.00		0.00
Manure	16.00	24.00		48.00	17.00		15.00		0.00
Chem fertilizer	28.37	28.01		123.98	24.62		63.60		0.61
Pesticides	58.00	58.00		430.00	45.00		33.00		0.75
Sacks	0.00	0.00		0.00	0.00		0.00		0.75
Mulch	20.40	0.00		20.40	20.40		0.00		0.00
Fuel & lubri	1.88	1.25		1.88	1.25		3.25		1.60
Labor , all other	22.50	25.00		180.00	32.00		31.00		1.05
harvest	25.00	25.00		155.00	28.00		10.00		0.00
Interest , wkg cap	14.96	21.12		107.30	14.72		28.59		3.04
Totals	202.03	332.38		1309.56	202.99		184.44		10.76
Stage Office 9	**Tomatoes**	**Potatoes**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92						0.00	0.00	2.96
Seed transplant 'g	8.00						0.00	0.00	0.00
Manure	16.00						15.00	37.50	0.00
Chem fertilizer	27.89						63.60	46.30	0.61
Pesticides	58.00						33.00	0.00	0.75
Sacks	0.00						0.00	0.00	0.75
Mulch	20.40						0	0	0.00
Fuel & lubri	1.88						3.25	3.25	1.60
Labor , all other	22.50						31.00	55.00	1.05
harvest	27.50						10.00	10.00	0.00
Interest , wkg cap	14.60						30.60	28.08	2.64
Totals	203.69						186.45	180.13	10.36

Cont. Appendix Table 5. Crop Production Costs , National Perspective (JD/dunum)

Stage Office 10	Tomatoes	Potatoes	Jew's Mal	Cucumber	Squash	Egg Plant	Citrus	Bananas	Wheat
Seeds						3.33	0.00	0.00	
Seed transplant 'g						10.00	0.00	0.00	
Manure						16.00	15.00	37.50	
Chem fertilizer						28.01	63.60	46.30	
Pesticides						61.00	33.00	0.00	
Sacks						0.00	0.00	0.00	
Mulch						20.40	0.00	0.00	
Fuel & lubri						1.50	3.25	3.25	
Labor , all other						45.00	31.00	55.00	
harvest						30.00	10.00	10.00	
Interest , wkg cap						16.11	30.60	28.08	
Totals						231.35	186.45	180.13	

Source : Forward , Vol. V.

Appendix Table 6. Crop Production Costs , Farmers Perspective * (JD /dunum).

Stage Office 1	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92					20.00	3.33	0.00	0.00	2.96
Manure	16.00					17.00	16.00	15.00	37.50	0.00
Chem fertilizer	27.89					24.62	28.01	63.60	46.30	0.61
Pesticides	58.00					45.00	61.00	33.00	0.00	0.75
Sacks	0.00					0.00	0.00	0.00	0.00	0.75
Mulch	20.40					20.40	20.40	0.00	0.00	0.00
Fuel & lubri	1.88					1.25	1.50	3.25	3.25	1.60
Hired harvesting labor	18.33					18.67	20.00	6.67	6.67	0.00
Interest , wkg cap	14.96					14.25	16.19	29.85	29.97	3.76
Totals	164.38					161.19	166.43	151.37	123.69	10.43
Stage Office 2	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92	150.00				20.00	3.33	0.00	0.00	2.96
Manure	16.00	24.00				17.00	16.00	15.00	37.50	0.00
Chem fertilizer	28.37	28.01				24.62	28.01	63.60	46.30	0.61
Pesticides	58.00	58.00				45.00	61.00	33.00	0.00	0.75
Sacks	0.00	0.00				0.00	0.00	0.00	0.00	0.75
Mulch	20.40	0.00				20.40	20.40	0		0.00
Fuel & lubri	1.88	1.25				1.25	1.50	3.25	3.25	1.60
Hired harvesting labor	16.67	16.67				18.67	20.00	6.67	6.67	0.00
Interest , wkg cap	14.51	21.01				14.25	16.11	29.85	29.97	3.76
Totals	162.75	298.94				161.19	166.35	151.37	123.69	10.43
Stage Office 3	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92	150.00			234.00	20.00		0.00	0.00	2.96
Manure	16.00	24.00			48.00	17.00		15.00	37.50	0.00
Chem fertilizer	27.89	28.01			123.98	24.62		63.60	46.30	0.61
Pesticides	58.00	58.00			430.00	45.00		33.00	0.00	0.75
Sacks	0.00	0.00			0.00	0.00		0.00	0.00	0.75
Mulch	20.40	0.00			20.40	20.40		0.00	0.00	0.00
Fuel & lubri	1.88	1.25			1.88	1.25		3.25	3.25	1.60

Cont. Appendix Table 6. Crop Production Costs, Farmers Perspective * (JD/dunum).

Hired harvesting labor	18.33	16.67			145.00	18.67		6.67	6.67	0.00
Interest , wkg cap	14.51	21.01			107.30	14.25		28.59	29.97	3.76
Totals	163.93	298.94			1110.56	161.19		150.11	123.69	10.43
Stage Office 4	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92		18.00	13.00		20.00		0.00		2.96
Manure	16.00		16.00	0.00		17.00		15.00		0.00
Chem fertilizer	28.37		24.17	6.12		24.62		63.60		0.61
Pesticides	58.00		20.00	0.00		45.00		33.00		0.75
Sacks	0.00		0.00	0.00		0		0.00		0.75
Mulch	20.40		20.40	0.00		20.40		0.00		0.00
Fuel & lubri	1.88		1.25	1.25		1.25		3.25		1.60
Hired harvesting labor	16.67		15.00	5.07		18.67		6.67		0.00
Interest , wkg cap	14.96		15.34	5.90		14.25		28.59		3.76
Totals	163.20		130.16	31.34		161.19		150.11		10.43
Stage Office 5	**Tomatoes**	**Potatoes**	**Faba bean**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92	150.00	18.00	13.00	234.00	20.00		0.00	0.00	2.96
Manure	16.00	24.00	16.00	0.00	48.00	17.00		15.00	37.50	0.00
Chem fertilizer	28.37	28.01	24.17	6.12	123.98	24.62		63.60	46.30	0.61
Pesticides	58.00	58.00	20.00	0.00	430.00	45.00		33.00	0.00	0.75
Sacks	0.00	0.00	0.00	0.00	0.00	0		0.00	0.00	0.75
Mulch	20.40	0.00	20.40	0.00	20.40	20.40		0.00	0.00	0.00
Fuel & lubri	1.88	1.25	1.25	1.25	1.88	1.25		3.25	3.25	1.60
Hired harvesting labor	16.67	16.67	15.00	5.07	145.00	18.67		6.67	6.67	0.00
Interest , wkg cap	14.96	21.12	15.33	5.96	107.30	14.72		28.59	30.44	3.04
Totals	163.20	299.05	130.15	31.40	1110.56	161.66		150.11	124.16	9.71

* Assumes family labor can account for onethird of harvesting, except for cucumbers, and not relevant for wheat.

Source: Forward, Vol. V.

Cont . Appendix Table 6. Crop Production Costs , Farmers Perspective * (JD /dunum).

Stage Office 6	**Tomatoes**	**Potatoes**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92					3.33	0.00	0.00	2.96
Manure	16.00					16.00	15.00	37.50	0.00
Chem fertilizer	27.89					28.01	63.60	46.30	0.61
Pesticides	58.00					61.00	33.00	0.00	0.75
Sacks	0.00					0.00	0.00	0.00	0.75
Mulch	20.40					20.40	0.00	0.00	0.00
Fuel & lubri	1.88					1.50	3.25	3.25	1.60
Hired harvesting labor	18.33					20.00	6.67	6.67	0.00
Interest , wkg cap	14.60					16.11	27.84	30.44	2.64
Totals	164.02					166.35	149.36	124.16	9.31
Stage Office 7	**Tomatoes**	**Potatoes**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92		13.00		20.00		0.00	0.00	2.96
Manure	16.00		0.00		17.00		15.00	37.50	0.00
Chem fertilizer	27.89		6.12		24.62		63.60	46.30	0.61
Pesticides	58.00		0.00		45.00		33.00	0.00	0.75
Sacks	0.00		0.00		0.00		0.00	0.00	0.75
Mulch	20.40		0.00		20.40		0.00	0.00	0.00
Fuel & lubri	1.88		1.25		1.25		3.25	3.25	1.60
Hired harvesting labor	18.33		5.07		9.50		6.67	6.67	0.00
Interest , wkg cap	14.51		5.45		14.25		29.85	30.52	3.76
Totals	163.93		30.89		152.02		151.37	124.24	10.43
Stage Office 8	**Tomatoes**	**Potatoes**	**Jew 's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92	150.00		234.00	20.00		0.00		2.96
Manure	16.00	24.00		48.00	17.00		15.00		0.00
Chem fertilizer	28.37	28.01		123.98	24.62		63.60		0.61
Pesticides	58.00	58.00		430.00	45.00		33.00		0.75
Sacks	0.00	0.00		0.00	0.00		0.00		0.75
Mulch	20.40	0.00		20.40	20.40		0.00		0.00
Fuel & lubri	1.88	1.25		1.88	1.25		3.25		1.60

Cont. Appendix Table 6. Crop Production Costs, Farmers Perspective * (JD/dunum).

Hired harvesting labor	16.67	16.67		145.00	18.67		6.67		0
Interest, wkg cap	14.96	21.12		107.30	14.72		28.59		3.04
Totals	163.20	299.05		1110.56	161.66		150.11		9.71
Stage Office 9	**Tomatoes**	**Potatoes**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds	6.92						0.00	0.00	2.96
Manure	16.00						15.00	37.50	0.00
Chem fertilizer	27.89						63.60	46.30	0.61
Pesticides	58.00						33.00	0.00	0.75
Sacks	0.00						0.00	0.00	0.75
Mulch	20.40						0	0	0.00
Fuel & lubri	1.88						3.25	3.25	1.60
Hired harvesting labor	18.33						6.67	6.67	0.00
Interest, wkg cap	14.60						30.60	28.08	2.64
Totals	164.02						152.12	121.80	9.31
Stage Office 10	**Tomatoes**	**Potatoes**	**Jew's Mal**	**Cucumber**	**Squash**	**Egg Plant**	**Citrus**	**Bananas**	**Wheat**
Seeds						3.33	0.00	0.00	
Manure						16.00	15.00	37.50	
Chem fertilizer						28.01	63.60	46.30	
Pesticides						61.00	33.00	0.00	
Sacks						0.00	0.00	0.00	
Mulch						20.40	0.00	0.00	
Fuel & lubri						1.50	3.25	3.25	
Hired harvesting labor						20.00	6.67	6.67	
Interest, wkg cap						16.11	30.60	28.08	
Totals						166.35	152.12	121.80	

* Assumed family labor can account for one-third of harvesting, except for cucumbers and not relevant for wheat

Source: Forward, Vol. V.

Appendix Table 7. Crop Rankings by Stage Office National Perspective

Crops	Yield (Kg/dunum)	Unit price (Fils/Kg)	Gross Rev (JD/dunum)	Prod. Cost (JD/dunum)	Net Rev (JD/dunum)
Stage Office 1					
Bananas	1200	420	504	182	322
Citrus	2622	170	446	186	260
Wheat *	260	256	67	11	56
Tomatoes	4900	50	245	204	41
Squash	1500	97	146	203	-58
Eggplant	3172	46	146	231	-85
Stage Office 2					
Bananas	1200	420	504	182	322
Citrus	2622	170	446	186	260
Wheat *	260	256	67	11	56
Tomatoes	4900	50	245	202	43
Potatoes	2253	137	309	332	-23
Squash	1500	97	146	203	-58
Eggplant	3122	46	144	231	-87
Stage Office 3					
Cucumber	10500	178	1869	1310	559
Bananas	1400	420	588	182	406
Tomatoes	4059	73	296	204	92
Citrus	1620	170	275	184	91
Wheat *	143	248	35	11	24
Potatoes	2240	137	307	332	-25
Squash	3076	30	92	203	-111
Stage Office 4					
Jew's mallow	1675	79	132	39	93
Tomatoes	3977	73	290	202	88
Citrus	1340	170	228	184	44
Faba bean	592	313	185	160	25
Wheat *	143	248	35	11	24
Squash	3076	30	92	203	-111
Stage Office 5					
Cucumber	10500	178	1869	1310	559
Bananas	1260	420	529	182	347
Jew's mallow	1624	79	128	39	89
Citrus	1555	170	264	184	80
Tomatoes	3808	73	278	202	76
Faba bean	696	313	218	160	58
Wheat *	143	248	35	11	24
Potatoes	2182	137	299	332	-33
Squash	3076	30	92	203	-111

Cont. Appendix Table 7. Crop Rankings by Stage Office
National Perspective

Stage Office 6					
Bananas	1260	420	529	182	347
Tomatoes	3377	73	247	204	43
Wheat *	107	255	27	10	17
Citrus	809	170	138	184	-46
Eggplant	2830	46	130	231	-101
Stage Office 7					
Bananas	1200	420	504	183	321
Citrus	2622	170	446	186	260
Wheat *	260	256	67	11	56
Tomatoes	4900	50	245	204	41
Jew's mallow	656	79	52	39	13
Squash	1500	97	146	203	-58
Stage Office 8					
Cucumber	10290	178	1832	1310	522
Tomatoes	3977	73	290	202	88
Citrus	1361	170	231	184	47
Wheat *	143	248	35	11	24
Potatoes	1979	137	271	332	-61
Squash	3076	30	92	203	-111
Stage Office 9					
Bananas	1570	420	659	180	479
Citrus	2570	170	437	186	251
Tomatoes	4900	73	358	203	155
Wheat *	143	255	36	10	26
Stage Office 10					
Bananas	1570	420	659	180	479
Citrus	2570	170	437	186	251
Eggplant	2830	46	130	231	-101

*Value of wheat includes yield and unit value of straw

Sources: Forward, Vol. II, Annex C for yields and Vol. V for unit prices and production costs. Note: the appendix section on methodology of our report explains the basis for reducing the production costs provided by Forward.

Appendix Table 8. Crop Rankings by Stage Office
Farmers Perspective

Crops	Yield (Kg/dunum)	Unit price (Fils/Kg)	Gross Rev (JD/dunum)	Prod. Cost (JD/dunum)	Net Rev (JD/dunum)
Stage Office 1					
Bananas	1200	420	504	124	380
Citrus	2622	170	446	151	295
Tomatoes	4900	50	245	164	81
Wheat *	260	256	67	10	57
Squash	1500	97	146	161	-16
Eggplant	3172	46	146	166	-20
Stage Office 2					
Bananas	1200	420	504	124	380
Citrus	2622	170	446	151	295
Tomatoes	4900	50	245	163	82
Wheat *	260	256	67	10	57
Potatoes	2253	137	309	299	10
Squash	1500	97	146	161	-16
Eggplant	3122	46	144	166	-22
Stage Office 3					
Cucumber	10500	178	1869	1111	758
Bananas	1400	420	588	124	464
Tomatoes	4059	73	296	164	132
Citrus	1620	170	275	150	125
Wheat *	143	248	35	10	25
Potatoes	2240	137	307	299	8
Squash	3076	30	92	161	-69
Stage Office 4					
Tomatoes	3977	73	290	163	127
Jew's mallow	1675	79	132	31	101
Citrus	1340	170	228	150	78
Faba bean	592	313	185	130	55
Wheat *	143	248	35	10	25
Squash	3076	30	92	161	-69
Stage Office 5					
Cucumber	10500	178	1869	1111	758
Bananas	1260	420	529	124	405
Tomatoes	3808	73	278	163	115
Citrus	1555	170	264	150	114
Jew's mallow	1624	79	128	31	97
Faba bean	696	313	218	130	88
Wheat *	143	248	35	10	25
Potatoes	2182	137	299	299	0
Squash	3076	30	92	162	-70

Cont. Appendix Table 8. Crop Rankings by Stage Office Farmers Perspective

Stage Office 6					
Bananas	1260	420	529	124	405
Tomatoes	3377	73	247	164	83
Wheat *	107	255	27	9	18
Citrus	809	170	138	149	-11
Eggplant	2830	46	130	166	-36
Stage Office 7					
Bananas	1200	420	504	124	380
Citrus	2622	170	446	151	295
Tomatoes	4900	50	245	164	81
Wheat *	260	256	67	10	57
Jew's mallow	656	79	52	31	21
Squash	1500	97	146	152	-7
Stage Office 8					
Cucumber	10290	178	1832	1111	721
Tomatoes	3977	73	290	163	127
Citrus	1361	170	231	150	81
Wheat *	143	248	35	10	25
Potatoes	1979	137	271	299	-28
Squash	3076	30	92	162	-70
Stage Office 9					
Bananas	1570	420	659	124	535
Citrus	2570	170	437	152	285
Tomatoes	4900	73	358	164	194
Wheat *	143	255	36	10	26
Stage Office 10					
Bananas	1570	420	659	122	537
Citrus	2570	170	437	152	285
Eggplant	2830	46	130	166	-36

*Value of wheat includes yield and unit value of straw

Sources: Forward, Vol. II, Annex C for yields and Vol. V for unit prices and production costs. Note the appendix section on methodology of our report explains the basis for reducing the production costs provided by Forward, as well as our reduction of labor costs except for harvesting.

Appendix Table 9. Overall Crop Rankings, National perspective

Crops	Yield (Kg/dunum)	Unit price (Fils/Kg)	Gross Rev (JD/dunum)	Prod. Cost (JD/dunum)	Net Rev (JD/dunum)	Location
Cucumber	10500	178	1869	1310	559	Stage Of. 3
Cucumber	10500	178	1869	1310	559	Stage Of. 5
Cucumber	10290	178	1832	1310	522	Stage Of. 8
Bananas	1570	420	659	180	479	Stage Of. 9
Bananas	1570	420	659	180	479	Stage Of.10
Bananas	1400	420	588	182	406	Stage Of. 3
Bananas	1260	420	529	182	347	Stage Of. 5
Bananas	1260	420	529	182	347	Stage Of. 6
Bananas	1200	420	504	182	322	Stage Of. 1
Bananas	1200	420	504	182	322	Stage Of. 2
Bananas	1200	420	504	183	321	Stage Of. 7
Citrus	2622	170	446	186	260	Stage Of. 1
Citrus	2622	170	446	186	260	Stage Of. 2
Citrus	2622	170	446	186	260	Stage Of. 7
Citrus	2570	170	437	186	251	Stage Of. 9
Citrus	2570	170	437	186	251	Stage Of.10
Tomatoes	4900	73	358	164	155	Stage Of. 9
Tomatoes	4059	73	296	204	92	Stage Of. 3
Citrus	1620	170	275	184	91	Stage Of. 3
Jew's mallow	1675	79	132	39	93	Stage Of. 4
Jew's mallow	1624	79	128	39	89	Stage Of. 5
Tomatoes	3977	73	290	202	88	Stage Of. 4
Tomatoes	3977	73	290	202	88	Stage Of. 8
Citrus	1555	170	264	184	80	Stage Of. 5
Tomatoes	3808	73	278	202	76	Stage Of. 5
Faba bean	696	313	218	160	58	Stage Of. 5
Wheat*	260	256	67	11	56	Stage Of. 1
Wheat*	260	256	67	11	56	Stage Of. 2
Wheat*	260	256	67	11	56	Stage Of. 7
Citrus	1361	170	231	184	47	Stage Of. 8
Citrus	1340	170	228	184	44	Stage Of. 4
Tomatoes	4900	50	245	202	43	Stage Of. 2
Tomatoes	3377	73	247	204	43	Stage Of. 6
Tomatoes	4900	50	245	204	41	Stage Of. 1
Tomatoes	4900	50	245	204	41	Stage Of. 7
Wheat*	143	255	36	10	26	Stage Of. 9
Faba bean	592	313	185	160	25	Stage Of. 4
Wheat*	143	248	35	11	24	Stage Of. 3
Wheat*	143	248	35	11	24	Stage Of. 4
Wheat*	143	248	35	11	24	Stage Of. 5
Wheat*	143	248	35	11	24	Stage Of. 8
Wheat*	107	255	27	10	17	Stage Of. 6
Jew's mallow	656	79	52	39	13	Stage Of. 7

Cont. Appendix Table 9. Overall Crop Rankings, National perspective

Potatoes	2253	137	309	332	-23	Stage Of. 2
Potatoes	2240	137	307	332	-25	Stage Of. 3
Potatoes	2182	137	299	332	-33	Stage Of. 5
Citrus	809	170	138	184	-46	Stage Of. 6
Squash	1500	97	146	203	-58	Stage Of. 1
Squash	1500	97	146	203	-58	Stage Of. 2
Squash	1500	97	146	203	-58	Stage Of. 7
Potatoes	1979	137	271	332	-61	Stage Of. 8
Eggplant	3172	46	146	231	-85	Stage Of. 1
Eggplant	3122	46	144	231	-87	Stage Of. 2
Eggplant	2830	46	130	231	-101	Stage Of. 6
Eggplant	2830	46	130	231	-101	Stage Of.10
Squash	3076	30	92	203	-111	Stage Of. 3
Squash	3076	30	92	203	-111	Stage Of. 4
Squash	3076	30	92	203	-111	Stage Of. 5
Squash	3076	30	92	203	-111	Stage Of. 8

* Includes the value of straw as a by-product

Sources: Forward, Vol. II, Annex C for yields and Vol V for unit prices and production costs Note: the appendix section on methodology of our report explains the basis for reducing the production costs provided by Forward

Appendix Table 10. Overall Crop Rankings , Farmers' perspective

Crops	Yield (Kg/dunum)	Unit price (Fils/Kg)	Gross Rev (JD/dunum)	Prod. Cost (JD/dunum)	Net Rev (JD/dunum)	Location
Cucumber	10500	178	1869	1111	758	Stage Of 3
Cucumber	10500	178	1869	1111	758	Stage Of 5
Cucumber	10290	178	1832	1111	721	Stage Of 8
Bananas	1570	420	659	122	537	Stage Of10
Bananas	1570	420	659	124	535	Stage Of 9
Bananas	1400	420	588	124	464	Stage Of 3
Bananas	1260	420	529	124	405	Stage Of 5
Bananas	1260	420	529	124	405	Stage Of 6
Bananas	1200	420	504	124	380	Stage Of 1
Bananas	1200	420	504	124	380	Stage Of 2
Bananas	1200	420	504	124	380	Stage Of 7
Citrus	2622	170	446	151	295	Stage Of 1
Citrus	2622	170	446	151	295	Stage Of 2
Citrus	2622	170	446	151	295	Stage Of 7
Citrus	2570	170	437	152	285	Stage Of 9
Citrus	2570	170	437	152	285	Stage Of10
Tomatoes	4900	73	358	164	194	Stage Of 9
Tomatoes	4059	73	296	164	132	Stage Of 3
Tomatoes	3977	73	290	163	127	Stage Of 4
Tomatoes	3977	73	290	163	127	Stage Of 8
Citrus	1620	170	275	150	125	Stage Of 3
Tomatoes	3808	73	278	163	115	Stage Of 5
Citrus	1555	170	264	150	114	Stage Of 5
Jew's mallow	1675	79	132	31	101	Stage Of 4
Jew's mallow	1624	79	128	31	97	Stage Of 5
Faba bean	696	313	218	130	88	Stage Of 5
Tomatoes	3377	73	247	164	83	Stage Of 6
Tomatoes	4900	50	245	163	82	Stage Of 2
Tomatoes	4900	50	245	164	81	Stage Of 1
Tomatoes	4900	50	245	164	81	Stage Of 7
Citrus	1361	170	231	150	81	Stage Of 8
Citrus	1340	170	228	150	78	Stage Of 4
Wheat**	260	256	67	10	57	Stage Of 1
Wheat**	260	256	67	10	57	Stage Of 2
Wheat**	260	256	67	10	57	Stage Of 7
Faba bean	592	313	185	130	55	Stage Of 4
Wheat**	143	255	36	10	26	Stage Of 9
Wheat**	143	248	35	10	25	Stage Of 3
Wheat**	143	248	35	10	25	Stage Of 4
Wheat**	143	248	35	10	25	Stage Of 5
Wheat**	143	248	35	10	25	Stage Of 8
Jew's mallow	656	79	52	31	21	Stage Of 7
Wheat**	107	255	27	9	18	Stage Of 6

Cont. Appendix Table 10. Overall Crop Rankings , Farmers' perspective

Potatoes	2253	137	309	299	10	Stage Of 2
Potatoes	2240	137	307	299	8	Stage Of 3
Potatoes	2182	137	299	299	0	Stage Of 5
Squash	1500	97	146	152	-7	Stage Of 7
Citrus	809	170	138	149	-11	Stage Of 6
Squash	1500	97	146	161	-16	Stage Of 1
Squash	1500	97	146	161	-16	Stage Of 2
Eggplant	3172	46	146	166	-20	Stage Of 1
Eggplant	3122	46	144	166	-22	Stage Of 2
Potatoes	1979	137	271	299	-28	Stage Of 8
Eggplant	2830	46	130	166	-36	Stage Of 6
Eggplant	2830	46	130	166	-36	Stage Of10
Squash	3076	30	92	161	-69	Stage Of 3
Squash	3076	30	92	161	-69	Stage Of 4
Squash	3076	30	92	162	-70	Stage Of 5
Squash	3076	30	92	162	-70	Stage Of 8

* Differs from the national perspective by removing the cost of family labor, except for two-thirds that required for harvesting because family labor is not sufficiently abundant to meet harvesting requirements. This two-thirds estimate does not apply to cucumbers, which require considerably more harvesting labor

* * Includes the value of straw as a by-product

Sources: Forward, Vol. II, Annex C for yields and VoV for unit prices and production costs. Note: the appendix section on methodology of our report explains the basis for reducing the production costs provided by Forward

Appendix Table 11. Historical Net Revenues from Cropping in the Northern Directorate, National perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	10,900	0.16	32,700	3	40	1,298
Citrus	52,500	0.76	52,500	1	244	12,802
Bananas * *	2,700	0.04	2,700	1	231	623
Wheat	2,900	0.04	5,800	2	42	245
Total	69,000	1.00	93,700			14,968

* Vegetable Yield x Stage Office

* * Values observed in the field represent bananas actually in production, whereas, bananas, according to the Forward report, Vol. V, show the following yield schedule. Consequently, the observed values are reduced by 31 percent.

Irrigated area, dunums	69,000
Net returns per irrigated area, JD/dunum	217
Cropping intensity	1.36

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jews mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	73					19	22	114	11022	606	404
StAGE 2	1032	1870				342	1031	4275	13267	252	40
StAGE 3	1541	1281			863	688		4373	4302	360	2128
StAGE 7	1090			1147		314		2551	16431	1112	2361
Totals	3736	3151		1147	863	1363	1053	11313	45022	2330	4933

Crop rankings. Net rev	Tomatoes	Potatoes	Faba bean	Jews mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	41					-58	-85		260	322	56
StAGE 2	43	-23				-58	-87		260	322	56
StAGE 3	92	-25			559	-111			91	406	24
StAGE 7	41			13		-58			260	321	56

Cont. Appendix Table 11. Historical Net Revenues from Cropping in the Northern Directorate, National perspective

Weighted avg net revenue	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	1					-1	-2		64	84	5
StAGE 2	12	-14				-15	-85		77	35	0
StAGE 3	38	-10			559	-56			9	63	10
StAGE 7	12			13		-13			95	153	27
Totals	63	-24		13	559	-85	-87		244	335	42
								Total Banana * 0.69		231	

Wtd avg total net rev/dun		Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
		21	-7		1	43	-10	-8	40			

An illustration	Net Rev (JD/dunum)
Establishment year	-200
Next year	0
Following five years	450
Annualized values over 6 yrs @ 10% interest	310
Annualized /five-year value	0.69

Appendix Table 12. Historical Net Revenues from Cropping in the Northern Directorate, Farmers' perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	10,900	0.16	32,700	3	89	2,922
Citrus	52,500	0.76	52,500	1	279	14,670
Bananas * *	2,700	0.04	2,700	1	271	732
Wheat	2,900	0.04	5,800	2	43	251
Total	69,000	1.00	93,700			18,574

* Vegetable Yield x Stage Office

**Values observed in the field represent bananas actually in production; whereas, bananas, according to the Forward report, Vol. V, show the following yield schedule. Consequently, the observed values are reduced by 31 percent.

Irrigated area, dunums	69,000
Net returns per irrigated area, JD/dunum	269
Cropping intensity	0.00

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	73					19	22	114	11022	606	404
StAGE 2	1032	1870				342	1031	4275	13267	252	40
StAGE 3	1541	1281			863	688		4373	4302	360	2128
StAGE 7	1090			1147		314		2551	16431	1112	2361
Totals	3736	3151	0	1147	863	1363	1053	11313	45022	2330	4933

Crop rankings. Net rev	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	81					-16	-20		295	380	57
StAGE 2	82	10				-16	-22		295	380	57
StAGE 3	132	8			758	-69			132	464	25
StAGE 7	81			21		-7			295	380	57

Cont. Appendix Table 12. Historical Net Revenues from Cropping in the Northern Directorate , Farmers' perspective

Weighted avg net revenue	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 1	1.58	0.00		0.00	0.00	-0.22	-0.42		72	99	5
StAGE 2	22.65	5.93		0.00	0.00	-4.01	-21.54		87	41	0
StAGE 3	54.45	3.25		0.00	758.00	-34.83	0.00		13	72	11
StAGE 7	23.63	0.00		21.00	0.00	-1.61	0.00		108	181	27
Totals	102	9		21	758	-41	-22		279	393	43
								Total Banana * 0.69		271	

Wtd avg total net rev /dun	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
	34	3		2	58	-5	-2	89			

An illustration	Net Rev (JD/dunum)
Establishment year	-200
Next year	0
Following five years	450
Annualized values over 6 yrs @ 10% interest	310
Annualized /five-year value	0.69

Appendix Table 13. Historical Net Revenues from Cropping in the Middle Directorate, National perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	27150	0.63	81450	3.00	70	5741
Citrus	13100	0.30	13100	1.00	54	710
Bananas **	250	0.01	250	1.00	239	60
Wheat	2500	0.06	5000	2.00	24	120
Total	43000	1.00	99800			6631

* Vegetable Yield x Stage Office

** Values observed in the field represent bananas actually in production ; whereas , bananas , according to the Forward report , Vol . V , show the following yield schedule . Consequently , the observed values are reduced by 31 percent .

Irrigated area , dunums	43,000
Net returns per irrigated area , JD/dunum	154
Cropping intensity	2.32

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	2700		511	1314		215		4740	1049		1266
StAGE 5	614	2434	908	112	653	1762		6483	1928	115	538
StAGE 8	1547	1095			768	201		3611	5392		1345
Totals	4861	3529	1419	1426	1421	2178		14834	8369	115	3149

Crop rankings . Net rev	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	88		25	93		-111			44		24
StAGE 5	76	-33	58	89	559	-111			80	347	24
StAGE 8	88	-61			522	-111			47		24

Cont. Appendix Table 13. Historical Net Revenues from Cropping in the Middle Directorate, National perspective

Weighted avg net revenue	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	49		9	86		-11			6	0	10
StAGE 5	10	-23	37	7	257	-90			18	347	4
StAGE 8	28	-19			282	-10			30	0	10
Totals	86	-42	46	93	539	-111			54	347	24
								Total Banana	* 0.69	239	

Wtd avg total net rev /dun	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
	28	-10	8	9	52	-16		70			

An illustration	Net Rev (JD /dunum)
Establishment year	-200
Next year	0
Following five years	450
Annualized values over 6 yrs @ 10% interest	310
Annualized /five-year value	0.69

Appendix Table 14. Historical Net Revenues from Cropping in the Middle Directorate , Farmers' perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	27,150	0.63	81,450	3	122	9,943
Citrus	13,100	0.3	13,100	1	88	1,156
Bananas **	250	0.01	250	1	279	70
Wheat	2,500	0.06	5,000	2	25	125
Total	43,000	1	99,800			11,293

* Vegetable Yield x Stage Office

**Values observed in the field represent bananas actually in production ; whereas, bananas, according to the Forward report , Vol. V, show the following yield schedule . Consequently, the observed values are reduced by 31 percent .

Irrigated area , dunums	43,000
Net returns per irrigated area , JD/dunum	263
Cropping intensity	2.32

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	2,700		511	1,314		215		4,740	1,049		1,266
StAGE 5	614	2,434	908	112	653	1,762		6,483	1,928	115	538
StAGE 8	1,547	1,095			768	201		3,611	5,392		1,345
Totals	4,861	3,529	1,419	1,426	1,421	2,178		14,834	8,369	115	3,149
								14834			

Crop rankings. Net r	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	127		55	101		-69			78		25
StAGE 5	115	0	88	97	758	-70			114	405	25
StAGE 8	127	-28			721	-70			81		25

Cont. Appendix Table 14. Historical Net Revenues from Cropping in the Middle Direct, Farmers' perspective

Weighted avg net re	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 4	71		20	93		-7			10	0	10
StAGE 5	15	0	56	8	348	-57			26	405	4
StAGE 8	40	-9			390	-6			52	0	11
Totals	125	-9	76	101	738	-70			88	405	25
								Total Banana* 0.69		279	

Wtd avg total net rev		Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
		41	-2	13	10	71	-10		122			

An illustration	Net Rev (JD/dunum)
Establishment year	-200
Next year	0
Following five years	450
Annualized values over6 yrs @ 10% interes	310
Annualized/five-year value	0.69

Appendix Table 15. Historical Net Revenues from Cropping in the Karameh Directorate, National perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	14,500	0.43	43,500	3.00	-33	-1,425
Citrus	4,300	0.13	4,300	1.00	63	272
Bananas **	14,300	0.42	14,300	1.00	330	4,717
Wheat	900	0.03	1,800	2.00	22	39
Total	34,000	0.57	63,900			3,604

* Vegetable Yield x Stage Office

** Values observed in the field represent bananas actually in production; whereas, bananas, according to the Forward report, Vol. V, show the following yield schedule. Consequently, the observed values are reduced by 31 percent.

Irrigated area, dunums	34,000
Net returns per irrigated area, JD/dunum	106
Cropping intensity	1.88

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	1,289						1,306	2,595	1,505	55	461
StAGE 9	45							45	30	3,400	506
StAGE 10							249	249	847	4,446	0
Totals	1,334						1,555	2,889	2,382	7,901	967

Crop rankings. Net re	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	43						-101		-46	347	17
StAGE 9	155								251	479	26
StAGE 10							-101		251	479	

Cont. Appendix Table 15. Historical Net Revenues from Cropping in the Karameh Directorate, National perspective

Weighted avg net revenu	Tomatoes	Potatoes	Faba bean	Jew 's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	41.55						-85		-29	2	8
StAGE 9	5.23						0		3	206	14
StAGE 10							-16		89	270	0
Totals	47						-101		63	478	22
								Total Banana	* 0.69	330	

Wtd avg total net rev	Tomatoes	Potatoes	Faba bean	Jew 's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
	22	0		0	0	0	-54	-33			

An illustration		Net Rev (JD/dunum)
Establishment year		-200
Next year		0
Following five years		450
Annualized values over	6 yrs @ 10% interest	310
Annualized /five-year value		0.69

Appendix Table 16. Historical Net Revenues from Cropping in the Karameh Directorate , Farmers' perspective

Crop	Irrigated Area (dunums)	Area (% of total)	Cropped Area (dunums)	Crop intensity	Net Rev (JD/du/crp)	Total Net Rev. (JD'000)
Vegetables *	14,500	0.43	43,500	3.00	21	899
Citrus	4,300	0.13	4,300	1.00	98	421
Bananas **	14,300	0.42	14,300	1.00	331	4,729
Wheat	900	0.03	1,800	2.00	22	40
Total	34,000	1.00	63,900			6,090

* Vegetable Yield x Stage Office

**Values observed in the field represent bananas actually in production ; whereas , bananas , according to the Forward report , Vol . V, show the following yield schedule . Consequently , the observed values are reduced by 31 percent .

Irrigated area , dunums	34,000
Net returns per irrigated area , JD/dunum	179
Cropping intensity	1.88

Area (dunums)	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	1,289						1,306	2,640	1,505	55	461
StAGE 9	45							294	30	3,400	506
StAGE 10							249	1,849	847	4,446	0
Totals	1,334						1,555	2,889	2,382	7,901	967

Crop rankings . Net rev	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	83						-36		-11	405	18
StAGE 9	194								285	535	26
StAGE 10							-36		285	537	

Cont. Appendix Table 16. Historical Net Revenues from Cropping in the Karameh Directorate, Farmers' perspective

Weighted avg net revenue	Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
StAGE 6	80.20						-30		-7	3	9
StAGE 9	6.54						0		4	174	14
StAGE 10							-6		101	302	0
Totals	87						-36		98	479	22
								Total Banana * 0.69		331	

Wtd avg total net rev /du		Tomatoes	Potatoes	Faba bean	Jew's mal	Cucumber	Squash	Eggplant	Totals	Citrus	Bananas	Wheat
		40						-19	21			

An illustration	Net Rev (JD/dunum)
Establishment year	-200
Next year	0
Following five years	450
Annualized values over 6 yrs @ 10% interest	310
Annualized /five -year value	0.69